Draft Westmead South Master Plan

Acoustic and Air Quality Impact Assessment

Cumberland City Council

15 April 2024

→ The Power of Commitment

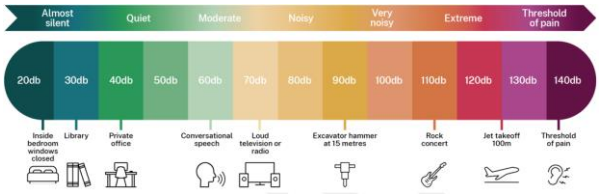
Project name		Westmead South Masterplan – Acoustic and Air Quality					
Document title		Draft Westmead South Master Plan | Acoustic and Air Quality Impact Assessment					
Project number		12609923					
File name		12609923_REP_WestmeadSouth_AAQIA_Stage2.docx					
Status Code	**Revision**	**Author**	**Reviewer**		**Approved for issue**		
			Name	**Signature**	**Name**	**Signature**	**Date**
S4	Final	A. Bagby R. Browell	E. Smith (Air quality) M Velasco (Acoustics)	*on file	E. Smith	*on file	15/04/24

GHD Pty Ltd | ABN 39 008 488 373
Contact: Marco Velasco, Acoustic Engineer | GHD
133 Castlereagh Street, Level 15
Sydney, New South Wales 2000, Australia
T +61 2 9239 7100 | **F** +61 2 9239 7199 | **E** sydmail@ghd.com | **ghd.com**

Acknowledgement of Country

GHD acknowledges Aboriginal and Torres Strait Islander peoples as the Traditional Custodians of the land, water and sky throughout Australia on which we do business. We recognise their strength, diversity, resilience and deep connections to Country. We pay our respects to Elders of the past, present and future, as they hold the memories, knowledges and spirit of Australia. GHD is committed to learning from Aboriginal and Torres Strait Islander peoples in the work we do.

Glossary of terms

Item	Description
µg/m^3	Micrograms per cubic metre
A-frequency weighting (dBA)	An adjustment made to sound level measurement, by means of an electronic filter, in line with international standards. This approximates the response of the human ear at lower sound pressure levels.
ADT	Average daily traffic refers to the total volume of vehicle traffic on a road for a period of one day or other relevant short-term period. This value is usually derived from either a short-term traffic count or by estimating based on other data
AADT	Annual average daily traffic or total volume of traffic passing a roadside observation point over the period of a calendar year, divided by the number of days in that year
AQMS	Air Quality Monitoring Station
BoM	Bureau of Meteorology
Buffer	An area of land between a roadway or rail corridor and a noise-sensitive land use, used as open space or for some other noise-tolerant land use.
Busy road	A busy road is defined as: – Roads specified in Clause 102 of the Infrastructure SEPP: a freeway, tollway or a transitway or any other road with an average annual traffic (AADT) volume of more than 40,000 vehicles (based on the traffic volume data provided on the website of the RTA). – Any other road – with an average annual daily traffic (AADT) volume of more than 20,000 vehicles (based on the traffic volume data published on the website of the RTA) – Any other road – with a high level of truck movements or bus traffic.
CLPP	Cumberland Local Planning Panel
CO	Carbon Monoxide
Council	Refers to Cumberland City Council
dB	Decibel, which is 20 times the logarithm (base 10) of the ratio of a given sound pressure to a reference pressure; used as a measure of sound.
DCP	Development Control Plan
Habitable room	Any room other than a garage, storage area, bathroom, laundry, toilet or pantry
Heavy vehicle	A truck, transport or other vehicle with a gross vehicle weight greater than 4.5 tonnes.
$L_{Aeq(period)}$	Equivalent A-weighted sound pressure level – the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring. Typical sound pressure levels are provided below for reference: 
$L_{Aeq(15hour)}$	The L_{Aeq} noise level for 7 am to 10 pm or the ‘day period’
$L_{Aeq(9hour)}$	The L_{Aeq} noise level for 10 pm to 7 am or the ‘night period’
$L_{Aeq(1hour)}$	The noise level representing the ’average maximum‘ one-hour noise level to the AM / PM peak
L_{A1}	The percentile sound pressure level exceeded for 1% of the measurement period with 'A' frequency weighting calculated by statistical analysis. L_{A1} is typically used to describe maximum noise events.
L_{A10}	The percentile sound pressure level exceeded for 10% of the measurement period with 'A' frequency weighting calculated by statistical analysis. L_{A10} road traffic noise levels are typically 3 dBA above L_{Aeq} road traffic noise levels.

Item	Description
L_{A90}	The percentile sound pressure level exceeded for 90% of the measurement period with 'A' frequency weighting calculated by statistical analysis. L_{A90} typically describes the background noise level.
L_{AFmax}	The maximum of the sound pressure levels recorded of a measurement period.
Local road	A road handling local traffic and characteristically having low or intermittent traffic flows.
LEP	Local Environmental Plan
NO_2	Nitrogen Dioxide
PM_{10}	Particulate matter with an equivalent aerodynamic diameter of 10 micrometres or less
$PM_{2.5}$	Particulate matter with an equivalent aerodynamic diameter of 2.5 micrometres or less
Rail corridor	as defined in the SEPP (Transport and Infrastructure): – Land that is owned, leased managed or controlled by a public authority for the purpose of a railway or rail infrastructure facilities, or – Land that is zoned under an environmental planning instrument predominantly or solely for the development for purpose of a railway or rail infrastructure facilities, or – Land in respect of which the Minister has granted approval under Part 3A or (before its repeal) Division 4 of Part 5 of the Act for the carrying out of development (or for a concept plan for a project comprising or including development) for the purpose of a railway or rail infrastructure facilities.
Road corridor	as defined in the SEPP (Transport and Infrastructure): – land that is used for the purposes of a road or road infrastructure facilities and owned or managed by a public authority, or – any land in respect of which the Minister has granted approval under Part 3A or Division 5.2 or (before its repeal) Division 4 of Part 5 of the Act, or consent under Part 4 of the Act, for the carrying out of development for the purpose of a road or road infrastructure facilities
Setback	The distance between the building alignment or face and the corresponding land boundaries of a property, which are controlled through planning regulation
Sensitive development	Development for any of the following purposes that is on land that is in or immediately adjacent to a rail corridor or busy road and the consent authority considers development is likely to be adversely affected by rail noise or vibration: i.e. a building for residential use, a place of public worship, a hospital or an educational establishment or childcare centre
SEPP	State Environmental Planning Policy

Contents

Table index

Figure index

Appendices


Aerial photo facing north
Milton Kent - 1935-45
State Library NSW

Introduction

Strategic planning framework to Westmead South and the purpose of this report

1. Introduction

1.1 Project background

Located within the Cumberland Local Government Area (LGA), Westmead South comprises the southern section of the Westmead Precinct, known as Australia's premier health and innovation district. Westmead South sits on the Cumberland LGA's northern border as it adjoins Parramatta LGA along the Main Western line. A mostly residential neighbourhood, Westmead South is a key centre of Cumberland City. Cumberland City Council is widely considered the geographic heart of the Greater Sydney area. It is located 1.7 kilometres from the Parramatta Central Business District (CBD) and 25 kilometres from the Sydney CBD.

The Greater Cities Commission (GCC) adopted *The Greater Sydney Region Plan, A Metropolis of Three Cities* in 2018 providing a new strategic direction for Greater Sydney over the next 40 years. The Plan provides a vision of three cities where most residents live within 30 minutes of their jobs, education and health facilities, services and great places including:

– The Eastern Harbour City
– The Central River City (where Westmead South is located)
– The Western Parkland City

This plan together with the GCC's *Central City District Plan*, Transport for NSW's *Future Transport 2056*, Infrastructure NSW's *State Infrastructure Strategy 2018-36* and the *Westmead 2036 - Place Strategy* has set the scene for major planning, investment and development in the Central City District of Sydney.

Cumberland City Council (Council) anticipates changes for Westmead South in the coming decades, due to significant infrastructure investment in the area, including the Metro Station, Parramatta Light Rail, and the rapidly growing health, education and innovation precinct. As the southern section of the Westmead Precinct, Westmead South will be crucial in supporting diverse housing opportunities, retail, and commercial uses, in the planned transformation of the wider precinct.

Council is aiming to prepare a planning framework based on the outcomes of this and other studies.

1.2 Purpose of this report

Excessive noise from nearby transportation noise including road, rail and aircraft can disrupt daily activities, sleep disturbances, and result in other health issues. Poor air quality can affect human health, amenity and quality of life. GHD has been engaged to assess the potential for acoustic and air quality amenity and health impacts on sensitive receivers for the following scenarios:

– **base-case**: existing built form and traffic volumes (the previous "Stage 1" report (GHD, Oct 2023))
– **future development scenario**: potential future built form resulting from the new planning framework for Westmead South and the forecast traffic volumes (this "Stage 2 report")

The key aims of the study are to investigate the following:

– The noise and air pollution sources within Westmead South that have potential to result in health or amenity impacts
– Opportunities to provide outcomes that protect the health or amenity of the community whilst enabling future development
– Appropriate and achievable controls to amend the Cumberland Local Environmental Plan 2021 and the Cumberland Control Plan 2021 in line with the relevant legislation, applicable guidelines and policies

1.3 Study area

The Westmead South study area is bound by a railway line to the north, the Great Western Highway to the south, Mays Hill Precinct (Parramatta Park) to the east and Bridge Road to the west as shown in Figure 1.1.

Westmead South is characterised by predominantly low to medium rise housing with a pocket of apartment development to the northeast of the site. Hawkesbury Road is currently the major north/south connection through the area, providing access onto the Great Western Highway and Western Motorway, which provides regional links across Greater Sydney. Oakes Centre, the neighbourhood shops provides some local services and amenities, however regional scale retail is located in Parramatta.

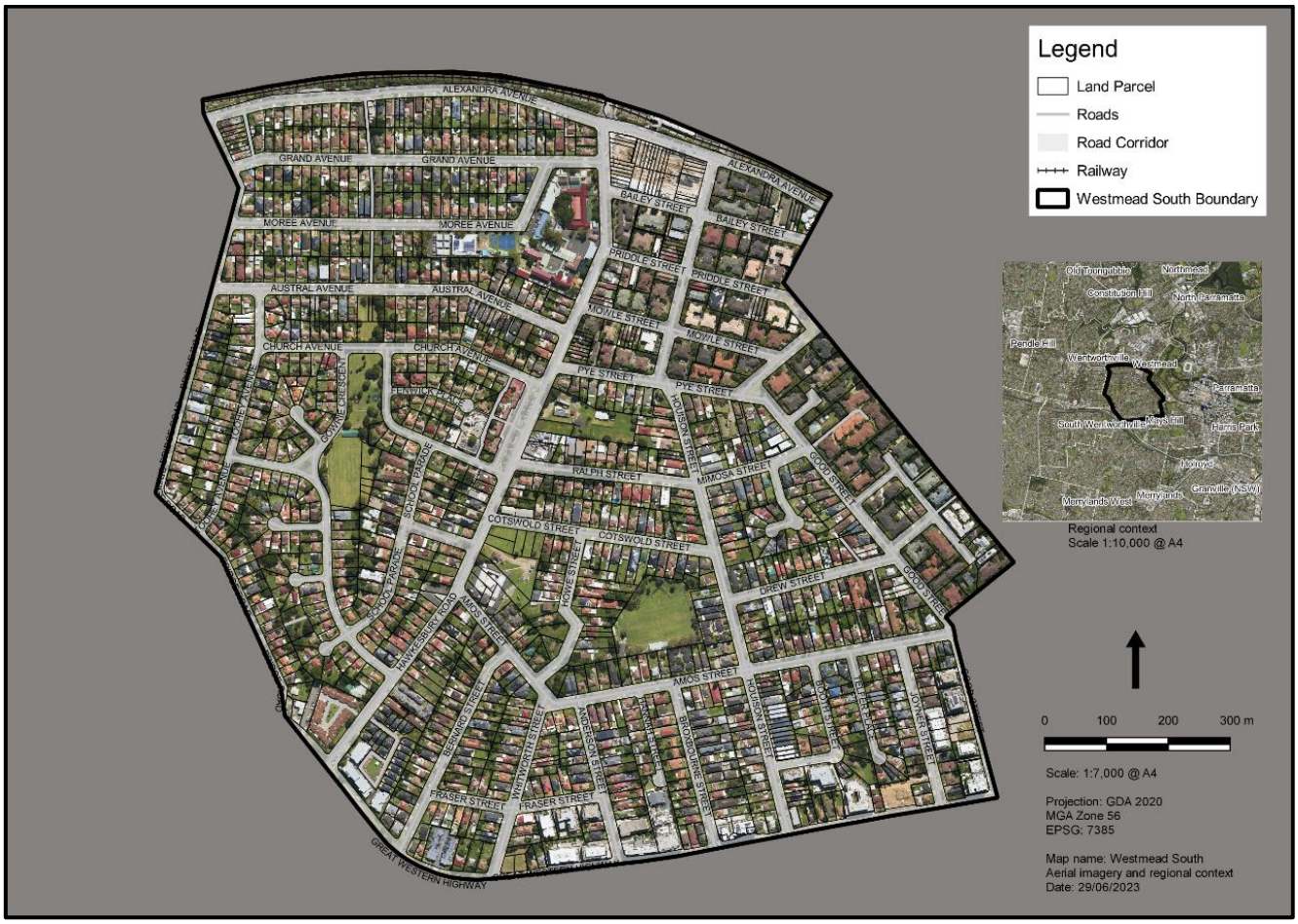


Figure 1.1 Westmead South study area

1.4 Strategic background

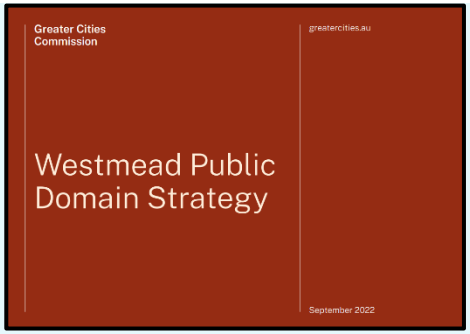
A literature review of the strategies, technical studies and major projects relevant to the assessment of acoustics and air quality in Westmead South has been undertaken and is summarised in Section 1.4 of the AAQIA Stage 1 report. This report assesses future development in Westmead South based on the Draft Master Plan and associated technical studies.

The state level strategies and Westmead South Draft Master Plan documents used to inform this assessment are summarised below.

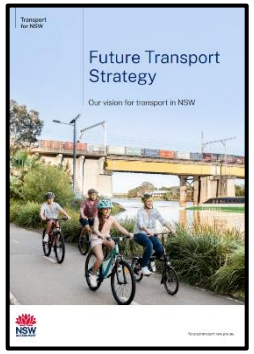
»NSW government strategies«

Westmead Place Strategy 2036

Westmead Place-based Transport Strategy

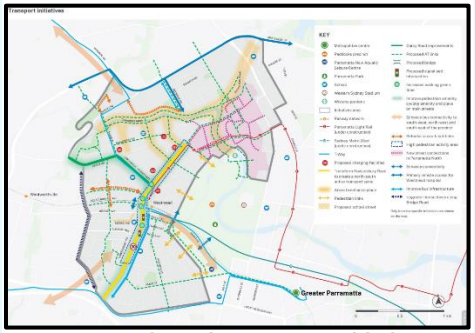


Westmead Public Domain Strategy

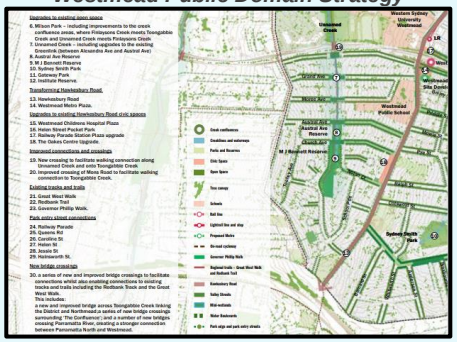


Future Transport Strategy 2056

Westmead South sub-precinct plan



Westmead South Transport Initiatives



Westmead South District Plan

Vision and outcomes

- Vision and planning framework for land in Westmead
- Structure plan demonstrating how land use, public domain improvements and future development will deliver this vision
- The Westmead Place Strategy has a Ministerial 9.1 Direction which requires any future rezoning to be consistent with the Place Strategy.

- An active transport spine on Hawkesbury Road, with improved pedestrian amenity, improved bus infrastructure and new signalised intersections.
- Enhanced connectivity across the railway
- Enhanced bus connectivity
- A 'school street' on Moree Avenue
- New active transport links

- 'Valley Streets' with 'Mini-wetlands' on sloping streets.
- 'Water Boulevards' along most other streets
- Detailed proposals for Hawkesbury Road, varying along its length.
- Detailed designs for the mid-block link between Austral Ave and Alexandra Ave.

- P4.2a Integrate air quality into strategic decision making, including at the assessment, strategic plan and design stages of projects.
- P4.2b Partner across Government to develop a transport network emissions model to identify high exposure areas and track changes.
- P4.2c Work with the Australian Government to introduce cleaner vehicle emissions and fuel quality standards. P4.2d Improve noise standards for monitoring and measuring

»Westmead South Draft Master Plan Documents«

Draft Westmead South Master Plan Strategy

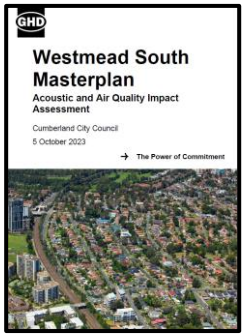
- Provides the Westmead South Draft Master Plan and the Master Plan Framework to guide the development of the Master Plan
- Describes the five key moves for Westmead South
- Identifies seven character areas each with unique built form and streetscape characters
- Describes the desired character and design guideline for each character area

Draft Westmead South Urban Design Report

- Focus on Hawkesbury Road High Street
- Connecting station and Oakes Centre
- Development within walking distance of Station, Westmead North and Parramatta CBD
- Approach to change by strategic, urban design and community aspirations
- Improve east-west and north-south link

Draft Westmead South Master Plan – Transport Study

- Hawkesbury Road transitioning from 'Arterial High Street' to 'Destination High Street' with lower vehicle movements
- Reconfiguration of Hawkesbury Road corridor and other intersection upgrades
- Alexander Avenue, Grand Avenue, Hassall Street south and Bridge Road would function as 'Connector Streets'
- Great Western Highway will remain as a 'Principal Arterial Road'



Westmead South Preliminary Acoustic and Air Quality Impact Assessment

- Baseline noise levels measured across the study area
- Validated noise model developed of existing transport noise conditions
- Identified Great Western Highway, Hawkesbury Road, Bridge Road and Alexandra Avenue as roads where a DA acoustic / air quality assessment is mandatory
- In-principle recommendations provided to reduce the potential for acoustic / air quality impacts

1.5 Summary of Stage 1 AAQIA report

Purpose of the report

The key focus of Stage 1 AAQIA report was to provide an analysis of the existing environment pertaining to air pollution, noise and vibration and provide a preliminary impact assessment on the 'base-case' (existing) scenario with respect to current legislation, policies and guidelines.

Outcomes of the noise and vibration impact assessment

No existing sensitive receivers were identified within 25 metres of an operational rail track. Given this, vibration from rail movements was not considered to be a significant acoustic amenity issue for receivers within the Westmead South study area.

Existing noise levels at key roads within Westmead South were quantified with 30-minute attended noise measurements (3 August 2023) and supplemented by previous unattended (long-term) noise monitoring undertaken by SLR in 2019. Simultaneous traffic counts were also undertaken at key roads and used as inputs into the noise model. A validated 3D noise model (SoundPLAN 8.2) was then used to predict façade noise levels across the study area. The key areas of concern within the Westmead South were identified to be receivers exposed to transport noise sources along:

– Great Western Highway (road)
– Hawkesbury Road (road)
– Bridge Road (road)
– Alexandra Road (road and rail)

New development along the following roads were identified as requiring an acoustic assessment to accompany the development application under the T&I SEPP mandatory requirements. The outcomes of the assessment also indicated that an acoustic assessment should be accompany development application for new sensitive development along the following roads (non-mandatory) to ensure the T&I SEPP internal noise levels can be achieved: Good Street, Pye Street, Amos Street, Houison Street, Hassall Street and Austral Avenue.

The acceptability of current transport noise levels would be dependent on the construction of individual buildings along the key roads to assess whether noise levels exceed 35 dBA in bedrooms during the night at 40 dBA for other habitable rooms during the day (T&I SEPP internal noise levels). Receivers along the roads listed above would require more than standard construction (i.e. acoustic treatment) to comply with the desired internal noise levels in the T&I SEPP. New development along these roads would be required to be designed to achieve the internal noise levels in the T&I SEPP.

Outcomes of the air quality assessment

Dispersion modelling was used to quantify the existing level of key air pollutants from road traffic. An assessment method was developed to determine the risk that incremental concentrations of $PM_{2.5}$ and NO2 from road traffic would lead to human health impacts at the receivers within the Westmead South Precinct study area. Areas with existing high and medium risk air quality included:

– Great Western Highway ($PM_{2.5}$ and NO2)
– Hawkesbury Road ($PM_{2.5}$)
– Bridge Road ($PM_{2.5}$)
– Alexandra Road ($PM_{2.5}$)

Design considerations for reducing air quality impacts for new developments in the precinct were provided and should be considered in those areas where existing air quality has been identified as high risk.

1.6 Report structure and methodology

The structure of the report and the key tasks undertaken to assess the potential acoustic and air quality impacts within the Westmead South Precinct are summarised in Table 1.1.

Table 1.1 Report structure and assessment methodology

Report chapter	Task
Chapter 1: Introduction and strategic background	Identify literature, previous technical studies, policies and guidelines relevant to the acoustic and air quality impact assessment
Chapter 2: Planning and policy context	Summarise the planning and policy context for the acoustic and air quality assessment
Chapter 3: Draft Master Plan summary	Summarise the outcomes of the Draft Master Plan strategy relevant to air quality and acoustic amenity
Chapter 4: Future impact assessment on future-case	Determine whether the forecasted future emission levels are acceptable based on current legislation, policies and guidelines. Assess the potential acoustic and air quality impacts on future development within the study area
Chapter 5: DCP planning controls	Provide recommendations for DCP planning controls based on the outcomes of the acoustics and air quality impact assessments

1.7 Limitations

This report: has been prepared by GHD for Cumberland City Council and may only be used and relied on by Cumberland City Council for the purpose agreed between GHD and Cumberland City Council as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Cumberland City Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section(s) 1.8 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

1.8 Assumptions

The Westmead South acoustics and air quality study is based on the following inputs provided by others and key assumptions:

- Mid-block traffic counts undertaken by Traffic Survey between 2 August 2023 and 9 August 2023 and supplied by SCT consulting
- Long-term unattended noise monitoring undertaken at four (4) locations within Westmead South as part of the *Westmead to the Bays and Sydney CBD Environmental Impact Assessment: Technical Paper 2 Noise and Vibration* (SLR, 2019)
- Future buildings have been based on data provided by the urban design team, *Architectus,* including the building footprint, building height, estimated number of floors and addresses
- 2 metre LiDAR elevation data was sourced from NSW Government – Spatial Services
- Road traffic noise levels were modelled at receivers using the algorithm Calculation of Road Traffic Noise 1988 (CoRTN)
- Rail traffic movements were modelled at receivers using the Nordic Prediction Method (NMT) 1996
- Vehicle air emissions were calculated from outputs from the *Computer program to calculate emissions from road transport* (COPERT 2014), using the 2010 NSW fleet characteristics, and surveyed vehicle counts.
- Local meteorology was modelled using GRAMM with input from NSW Government's Parramatta North Air Quality Monitoring Station
- Air dispersion modelling was undertaken using the Graz Lagrangian Model (GRAL)
- The vibration assessment zone for typical development sites adjacent to rail corridors or above (built) rail tunnels is 25 metres for residential buildings on hard ground such as sandstone (*Development Near Rail Corridors and Busy Roads - Interim Guideline,* DoP 2008). No existing sensitive receivers have been identified within 25 metres of an operational rail track. Given this, vibration from rail movements is not considered to be an acoustic amenity issue for the Westmead South study area. For the receivers near the rail track, this study focuses on the dominant noise sources being airborne noise from rail and road traffic.
- Existing planning controls were extracted from ArcGIS Feature Service spatial datasets of NSW environmental planning instruments (EPI)
- The modelling undertaken for this report is based on the Draft Master Plan built form provided by Architects in October 2023 and has been slightly revised in April 2024. However, the changes are considered minor and would not materially affect the conclusions and recommendations made in this report.

Planning and policy context

Key legislation and design principles informing the assessment

2. Planning and policy context

This AAQIA study primarily focuses on the potential air, noise and vibration pollution impacts on future development within the Westmead South Precinct to inform the development of the Westmead Master Plan and relevant planning controls. The key legislation, design guidance and policies relevant to this study are highlighted in light blue in Table 2.1. Other relevant NSW legislation and guidelines pertaining to acoustics and air quality are summarised in Table 2.1, however have not been specifically considered in this study.

Section 2 of the Stage 1 report provides a detailed description of the key legislation, polices and design guidance relevant to air, noise and vibration pollution relevant to Westmead South.

Table 2.1 Relevant legislation, guidelines and policies

Type	Document
Key legislation and policies	– Cumberland LEP 2021 – EP&A Act 1979 and EP&A Regulation 2000 – Transport and Infrastructure SEPP 2021 – Housing SEPP – National Environment Protection Council (NEPC) National Environment Protection (Ambient Air Quality) Measure 2021 (the Air NEPM)
Key design guidance for future development within Westmead South Precinct	– Cumberland DCP 2021 – Development Near Rail Corridors and Busy Roads - Interim Guideline – NSW Apartment Design Guide – Low Rise housing Diversity Design Guide for DAs and CDCs
Relevant NSW legislation	– Protection of the Environment Operations Act 1997 – Protection of the Environment Operations (Noise Control) Regulation 2017 – NSW Protection of the Environment Operations (Clean Air) Regulation 2021 (POEO Clean Air Regulation) – Liquor Act 2007 and Liquor Regulation 2018 – Local Government Act 1993 – Strata Schemes Management Act 2015
Relevant noise and vibration specific guidelines	– Noise Policy for Industry (EPA 2017) – Interim Construction Noise Guideline (DECCW 2009) – Noise Guide for Local Government – NSW Road Noise Policy (DECCW 2011) – NSW Rail Infrastructure Noise Guideline (EPA 2013) – Assessing Vibration: A technical guideline (DEC 2006) – AS2107:2016 Acoustics Recommended design sound levels and reverberation times for building interiors – Building Code of Australia – AAAC Guidelines of acoustic assessments
Relevant air quality specific guidelines	– NSW EPA Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (2022) (the Approved Methods)

For acoustics, the main piece of legislation providing a consistent planning regime for infrastructure and the provision of services across NSW is the *Transport and Infrastructure SEPP 2021*. If the consent authority considers that land is in or adjacent to a rail corridor or a busy road is likely to be adversely affected by noise, vibration or vehicle emissions, the consent authority must not consent to a residential development unless it is satisfied that appropriate measures will be taken to ensure that the internal L_{Aeq} noise levels prescribed in the SEPP can be achieved and that vehicle emissions can be adequately controlled.

Amendments to the Housing SEPP 2021 came into effect in December 2023 and repeals SEPP 65 – Design Quality of Residential Apartment Development. The amendment incorporates provisions regarding the design of residential development, and application of the Apartment Design Guide into the Housing SEPP.

Draft Master Plan summary

Summary of the objectives and actions relevant to acoustics and air quality

3. Draft Master Plan

3.1 Westmead South character areas

The Draft Westmead South Urban Design Report (Architectus, Oct 2023) identifies seven character areas within Westmead South each with unique built form and streetscape qualities.

The seven character areas are shown in Figure 3.1 below and the character and indicative built forms are summarised in Table 3.1.

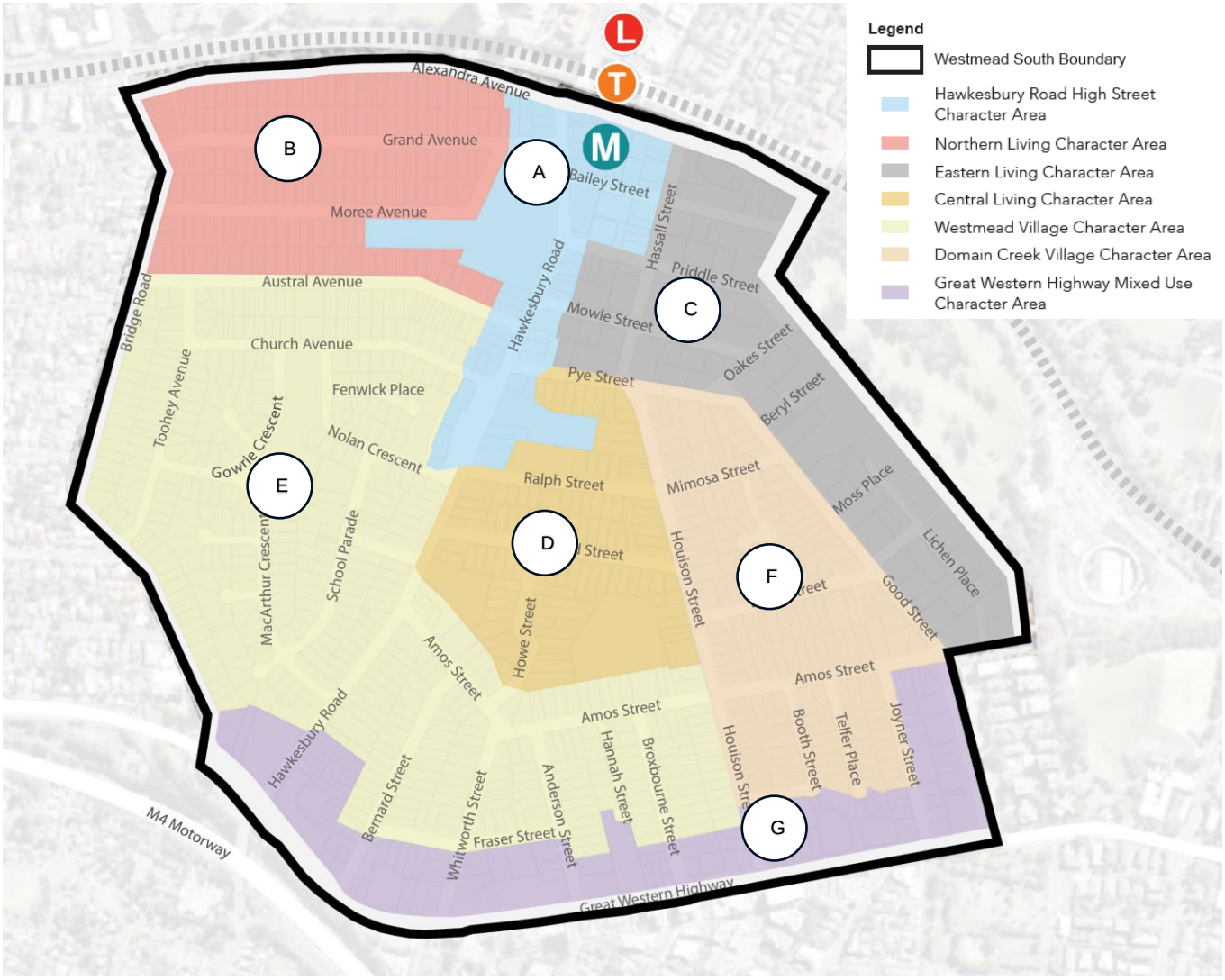
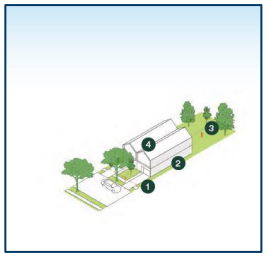
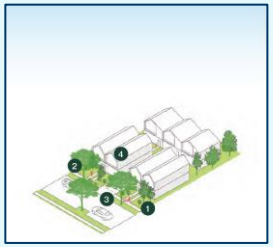


Figure 3.1 Westmead South Character Areas

Table 3.1 Westmead South character areas and indicative built forms

Character area	Description	Indicative built form	Character area	Description	Indicative built form
A: Hawkesbury Road High Street 	The village centre - a focus for community		**E: Westmead Village** 	Low scale housing with landscape and historical qualities with MJ Bennett Reserve at its heart	
B: Northern Living 	New housing within a short walk of public transport and key attractors		**F: Domain Creek** 	Low-rise setting of this area to be protected, with the area characterised by low to medium density dwellings.	
C: Eastern Living 	Medium density neighbourhood in walking distance to two parks		**G: Great Western Hwy** 	Commercial corridor with quick connections into Parramatta	
D: Central Living 	A green neighbourhood with medium high density living around Sydney Smith Park				

3.2 Proposed development areas

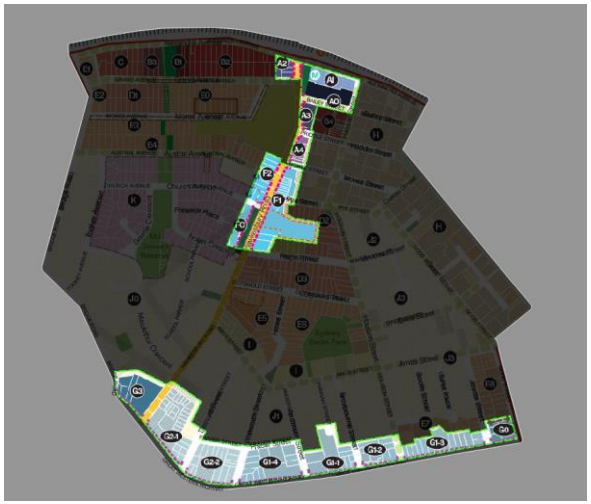
The built form approach for Westmead South including the proposed land uses, building height (storeys) and floor space ratio (FSR) is presented in Figure 3.1. The proposed development areas are shown in Figure 3.2 and described in Table 3.2, based on the revised Draft Master Plan dated 8 April 2024.

For the purpose of this acoustics and air quality study, the Westmead South development areas have been grouped into the following assessment categories, based on the proposed land use and built form:

– Mixed-use buildings
– Residential flat buildings
– Low to medium residential

Figure 3.2 Development areas (land use, FSR and building height approach)

Table 3.2 Assessment categories and master plan development areas

Assessment category name	ID	Master Plan Development Areas	No. of storeys	Floor space ratio (FSR)	Key character areas	Assessment category map
Mixed use	**A0**	Mixed use (Adjacent Station Development)	25	5.9:1	– Hawkesbury Road High Street – Great Western Highway Mixed Use	
	A1	Metro site – station entrance and supporting services	1-2	0.5:1		
	A2	Mixed use	20	4.5:1		
	A3	Mixed use	20	2.8:1		
	A4	Mixed use	15	2.8:1		
	F0	Mixed use (Hawkesbury Rd high street)	8	3.2:1		
	F1	Mixed use (Hawkesbury Rd high street)	8	3.2:1		
	F2	Mixed use (Hawkesbury Rd high street)	8	3.2:1		
	G0	Mixed use (GHW E3 zone)	8	2.5:1		
	G1-1	Mixed use (GHW E3 zone)	8	2.2:1		
	G1-2	Mixed use (GHW E3 zone)	8	2.2:1		
	G1-3	Mixed use (GHW E3 zone)	8	2.2:1		
	G1-4	Mixed use (GWH extension)	8	2.2:1		
	G2-1	Mixed use (GWH extension)	6	1.8:1		
	G2-2	Mixed use (GWH extension)	6	1.8:1		
	G3	Hawkesbury Place site	12	3.0:1		
Residential flat buildings (RFBs)	**B1**	High density residential	25	3.6:1	– Northern Living – Central Living – Eastern Living	
	B2	Residential apartments	15	3.6:1		
	B3	Residential apartments	20	3.6:1		
	B4	Residential apartments	15	3.2:1		
	C	Residential apartments	12	2.9:1		
	D1	Residential apartments	8	2.5:1		

Assessment category name	ID	Master Plan Development Areas	No. of storeys	Floor space ratio (FSR)	Key character areas	Assessment category map
	D2	Residential apartments	8	2.5:1		
	D3	Residential apartments	8	2.5:1		
	E0	Residential apartments	4	1.2:1		
	E1	Residential apartments	6	1.6:1		
	E2	Residential apartments	6	1.6:1		
	E3	Residential apartments	6	1.6:1		
	E4	Residential apartments	6	1.6:1		
	E5	Residential apartments	6	1.6:1		
	E6	Residential apartments	6	1.6:1		
	E7	Residential apartments	6	1.6:1		
	E8	Residential apartments	6	1.6:1		
	H	*Residential apartments (existing blocks)*	4	1.2:1 (no change)		
Low and medium density residential	**I**	Medium density residential	2	0.7:1	– Westmead Village – Domain Creek Village	
	J0	Low to medium density residential	2	0.7:1		
	J1	Low to medium density residential	2	0.7:1		
	J2	Low to medium density residential	2	0.7:1		
	J3	Low to medium density residential	2	0.7:1		
	K	Potential special character area or heritage conservation area	1	-		

Future assessment

An assessment of the future air quality and noise levels against the relevant guidance and criteria

4. Future development scenario

4.1 Noise assessment

Noise modelling

Noise modelling was undertaken using the SoundPLAN 8.2 software package to predict future façade noise levels at buildings within the future Westmead South precinct. The 'base-case' noise model was prepared based off the calibrated transportation noise model used in the Stage 1 report. Full details of the calibrated model and Stage 1 modelling is found in Section 4.1 of the Stage 1 report. An overview of the transportation noise model is provided below in Figure 4.1.

The 'base-case' noise model has been updated to account for the following key changes associated with the proposed development areas within Westmead South:

– **Change in traffic volumes**: Future traffic volumes for the year 2041 based on information provided by SCT Consulting (see Appendix C)
– **Master Plan built form**: Indicative future built form within Westmead South based on the Westmead South Draft Master Plan provided by Architectus

The following sections summarise the results of the 'future development scenario' noise modelling. The SoundPLAN model developed to predict noise levels at future development areas across the Westmead South study area is shown in Figure 4.1.

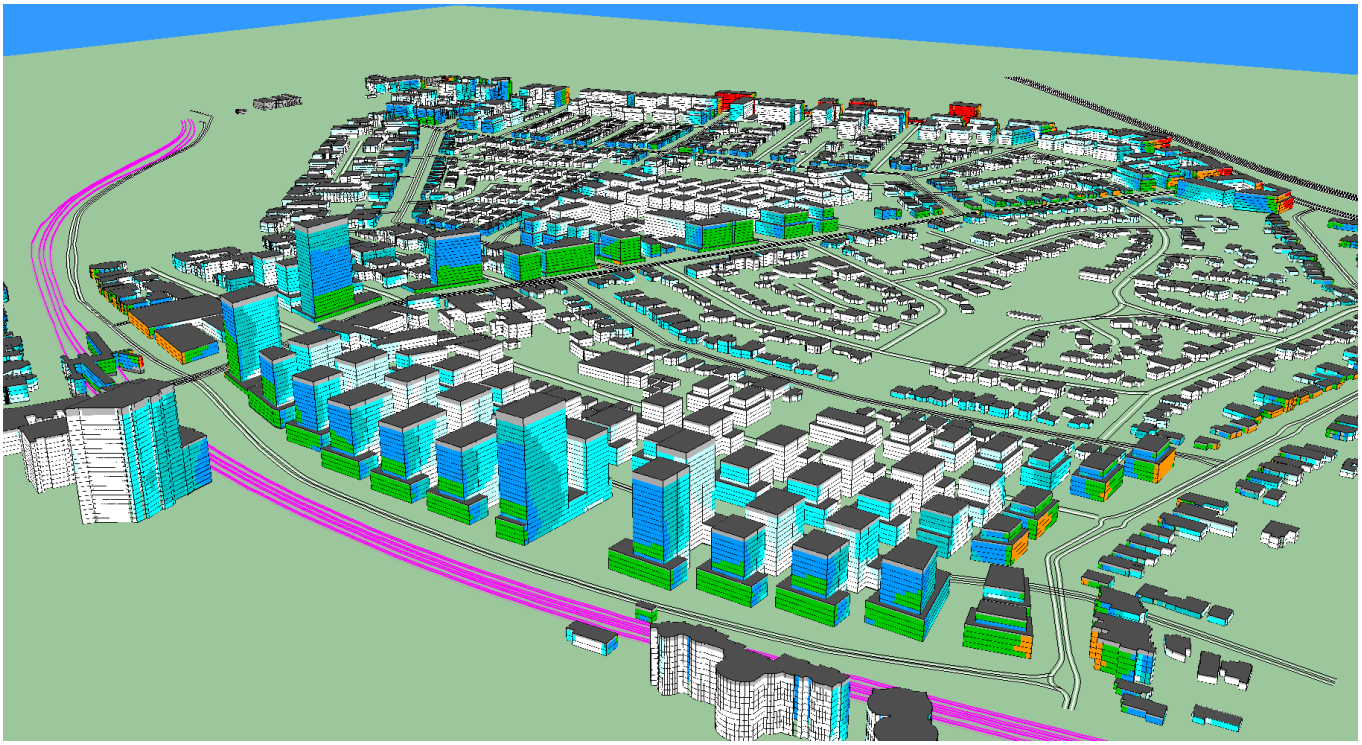


Figure 4.1 SoundPLAN 8.2 transportation noise model overview

Future transport noise levels

The proposed masterplan development areas have been grouped for assessment purposes based on their overall typographies into assessment categories; '**mixed-use'**, '**residential flat buildings'** and '**low to medium density residential**'. The distribution of noise levels at residential properties for each development area in each assessment category is also provided. The results represent the worst-impacted façade per building to gain an understanding of the likely mitigation required when designing the building. The number of storeys and floor-to-space ratio (see Table 3.2) for each development area should also be considered when interpreting the results.

A statistical distribution for each assessment category is provided below from Figure 4.2 to Figure 4.7 in the form of box and whisker plots, where:

– The **box** represents the interquartile range (upper quartile, median and lower quartile) of the worst-case façade noise level per building for each assessment category area
– The **whiskers** are indicative of the 'minimum' and 'maximum' of the worst-case façade noise levels per building for each assessment category area
– The **'X**' presents the mean of the worst-case façade noise level per building in the assessment category area

Outliers have been excluded from the results for the purposes of this study.

Each figure also shows the dwellings or developments where more than standard construction would likely be required to achieve the T&I SEPP internal noise levels for the day and night periods. This assumes that the noise reduction provided by a standard construction façade is 24 dBA (equivalent to masonry or light weight external wall with 5 mm thick standard glazing). The relevant façade noise level threshold is hence assumed at 60 and 55 dBA for day and night levels respectively. Results for the most-affected residences (Highest 90th percentile noise levels) are also shown Table 4.1.

Mixed use development (up to 25 storeys)

Mixed-use development is proposed in the Westmead South character areas 'Hawkesbury Road High Street' and 'Great Western Highway'. The modelling results for the day period are shown in Figure 4.2 and the results for the night period are shown in Figure 4.3.

The results indicate that future mixed-use development within the 'Hawkesbury Road High Street' (A0 to A4 and F0, F1) and 'Great Western Highway' (G0 to G3) would require an acoustic assessment and the building adequately designed to achieve the T&I SEPP internal noise levels.

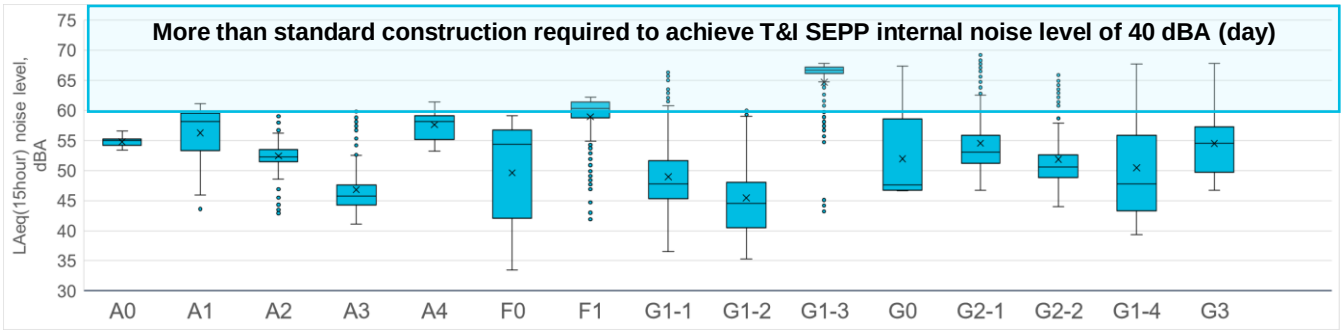


Figure 4.2 Day period façade noise levels at sensitive receivers – Mixed use / high density

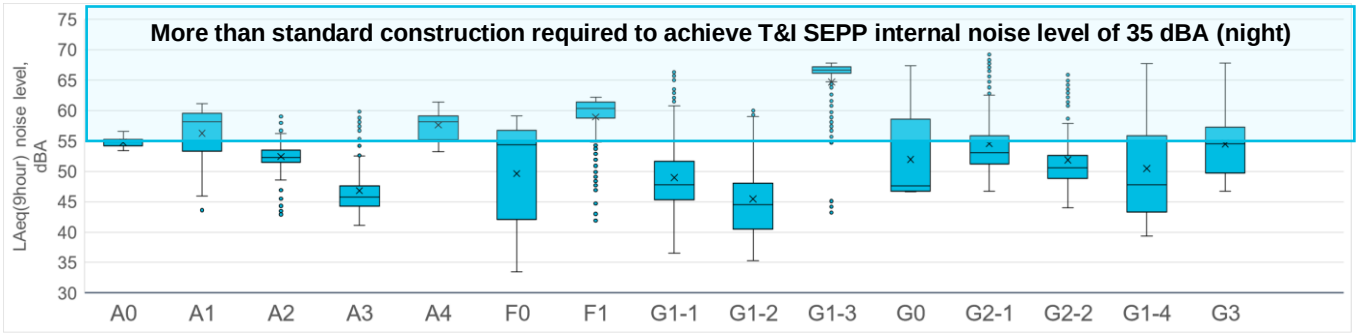


Figure 4.3 Night period façade noise levels at sensitive receivers – Mixed use / high density

Residential flat building development (up to 25 storeys)

Development areas including residential flat buildings are proposed in the Westmead South character areas 'Northern Living', 'Central Living' and 'Eastern Living'. The modelling results for the day period are shown in Figure 4.4 and the results for the night period are shown in Figure 4.5.

The results indicate that future RFB development within the 'Northern Living' character area (B2, B3, B4, C, D2, E1, E2 and E4) and 'Central Living' (E5, E7 and E8) would require an acoustic assessment and the building

adequately designed to achieve the T&I SEPP internal noise levels. Residential development adjacent to Bridge Road and Hawkesbury Road within the 'Northern Living' and 'Central Village' character areas (D and E) would also require an acoustic assessment, however for the majority of the development areas, standard construction would suffice.

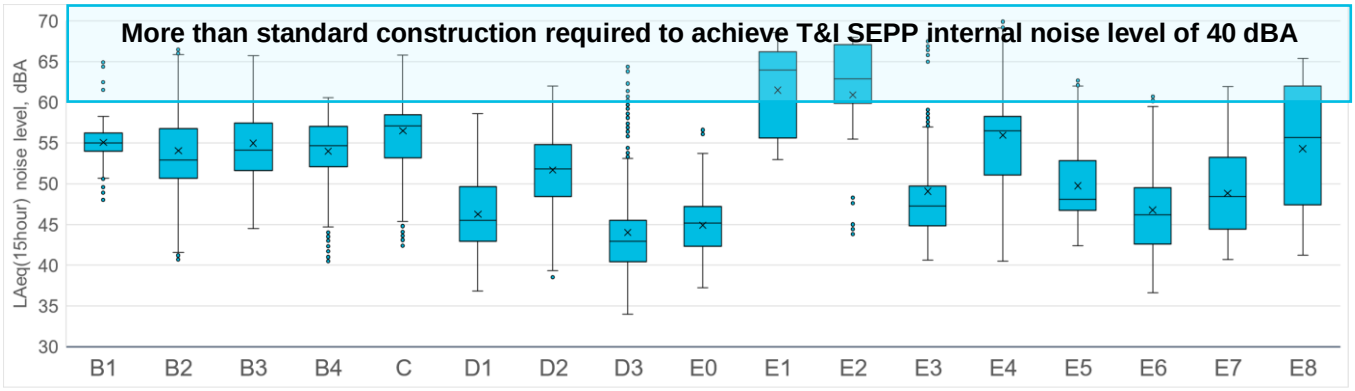


Figure 4.4 Day period façade noise levels at sensitive receivers – Residential flat buildings

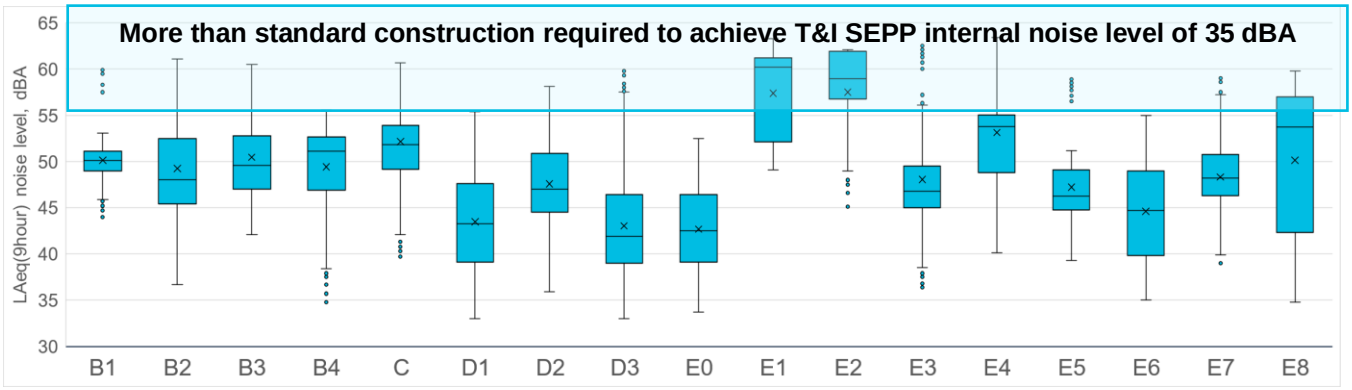


Figure 4.5 Night period façade noise levels at sensitive receivers – Residential flat buildings

Low to medium density residential (up to two storeys)

The Westmead South character areas 'Westmead Village' and 'Domain Creek Village' would comprise of low to medium density residential development. The modelling results for the day period are shown in Figure 4.6 and the results for the night period are shown in Figure 4.7.

The results indicate that future low and medium density residential development within the 'Westmead Village' (I, J0, J1 and K) and 'Domain Creek' (J2 and J3) character areas and fronting either Bridge Road or Hawkesbury Road would require an acoustic assessment and the building adequately designed to achieve the T&I SEPP internal noise levels.

There is also potential for residential properties within the 'Eastern Living' character area (I) that front either Amos Street, Housion Street or Good Street to require acoustic treatment to achieve the T&I SEPP internal noise levels. However, for the majority of the low to medium density residential development areas, standard construction would suffice.

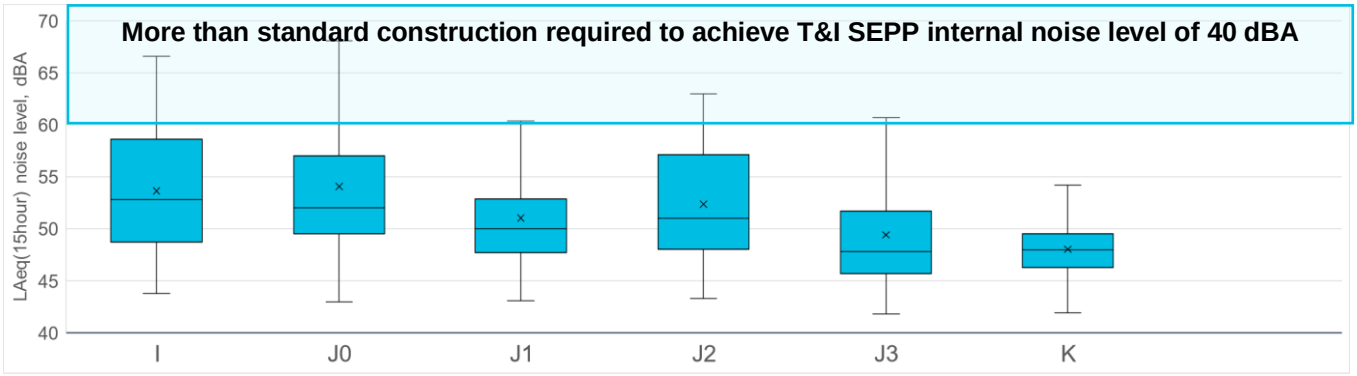


Figure 4.6 Day period façade noise levels at sensitive receivers – Low density residential

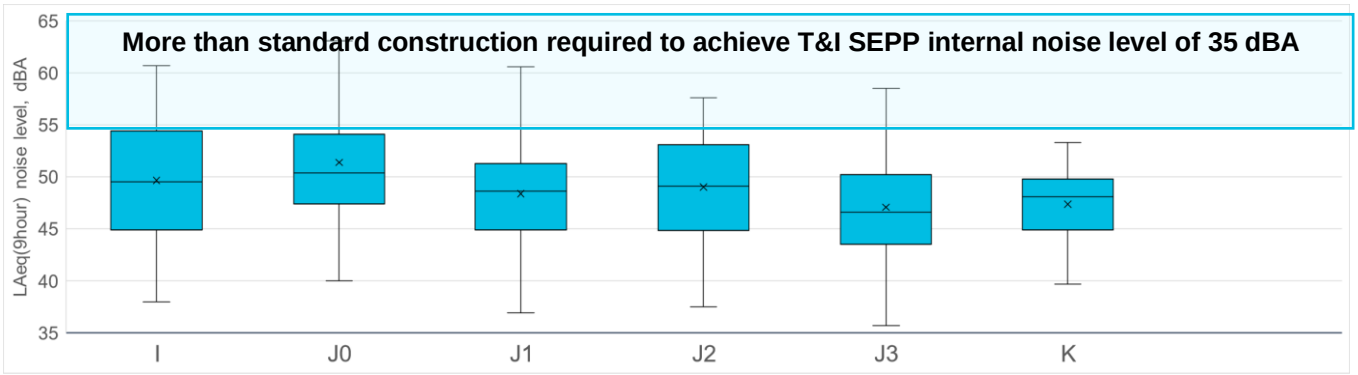


Figure 4.7 Night period façade noise levels at sensitive receivers – Low density residential

Summary of façade noise levels across Westmead South

Results for the most-affected residences (Highest 90th percentile noise levels) are also shown in Table 4.1.

The key development areas that require special acoustic consideration to achieve the desired T&I SEPP internal noise levels are:

1. Future mixed-use development fronting Great Western Highway (G0 through to G3)
2. Future mixed use and RFB development fronting Alexandra Avenue (A1, A2, B1, B2, B3, C and E1) and fronting the Hawkesbury Road High Street area (F0, F1, F2, A3 and A4)

Table 4.1 Worst-case façade noise levels at residential receivers and indicative internal noise levels, dBA

Assessment category	Masterplan development area	Day (T&I SEPP internal design noise level of 40 dBA) Habitable rooms other than bedrooms					Night (T&I SEPP internal design noise level of 35 dBA) Bedrooms				
		Statistical external façade noise levels		Most-affected residences (Highest 90th percentile)			Statistical external façade noise levels		Most-affected residences (Highest 90th percentile)		
		Median noise level, dBA	Maximum noise level, dBA	External noise level, dBA	Estimated internal noise level, dBA[1]	Additional reduction required, dBA	Median noise level, dBA	Maximum noise level, dBA	External noise level, dBA	Estimated internal noise level, dBA[1]	Additional reduction required, dBA
Mixed Use	A0	61	62	61	37	-	55	57	56	32	-
	A1	64	68	67	43	3 (Rw 28)	58	61	60	36	-
	A2	58	64	61	37	-	52	59	57	33	-
	A3	51	63	59	35	-	46	60	57	33	-
	A4	61	65	65	41	1 (Rw 26)	58	61	61	37	-
Residential flat buildings	B1	55	65	58	34	-	50	60	53	29	-
	B2	53	67	66	42	2 (Rw 27)	48	61	61	37	-
	B3	54	66	65	41	1 (Rw 26)	50	61	60	36	-
	B4	55	61	60	36	-	51	56	55	31	-
	C	57	66	65	41	1 (Rw 26)	52	61	61	37	-
	D1	46	59	55	31	-	43	55	52	28	-
	D2	52	62	60	36	-	47	58	56	32	-
	D3	43	65	56	32	-	42	60	53	29	-
	E0	45	57	50	26	-	43	53	49	25	-
	E1	64	69	67	43	3 (Rw 28)	60	63	62	38	-
	E2	63	68	68	44	4 (Rw 29)	59	62	62	38	-
	E3	47	68	67	43	3 (Rw 28)	47	63	62	38	-
	E4	57	70	69	45	5 (Rw 30)	54	63	63	39	-
	E5	48	63	62	38	-	46	59	58	34	-
	E6	46	61	60	36	-	45	55	55	31	-
	E7	48	62	57	33	-	48	59	55	31	-

Assessment category	Masterplan development area	Day (T&I SEPP internal design noise level of 40 dBA) Habitable rooms other than bedrooms					Night (T&I SEPP internal design noise level of 35 dBA) Bedrooms				
		Statistical external façade noise levels		Most-affected residences (Highest 90th percentile)			Statistical external façade noise levels		Most-affected residences (Highest 90th percentile)		
		Median noise level, dBA	Maximum noise level, dBA	External noise level, dBA	Estimated internal noise level, dBA[1]	Additional reduction required, dBA	Median noise level, dBA	Maximum noise level, dBA	External noise level, dBA	Estimated internal noise level, dBA[1]	Additional reduction required, dBA
	E8	56	65	64	40	-	54	60	59	35	-
Mixed use	F0	59	63	63	39	-	54	59	58	34	-
	F1	65	67	66	42	2 (Rw 27)	60	62	62	38	-
	F2	53	66	65	41	1 (Rw 26)	51	61	61	37	-
	G0	45	73	73	49	9 (Rw 34)	48	67	67	43	3 (Rw 33)
	G1-1	50	72	66	42	2 (Rw 27)	48	67	62	38	-
	G1-2	50	64	62	38	-	45	60	58	34	-
	G1-3	72	73	73	49	9 (Rw 34)	67	68	68	44	4 (Rw 34)
	G1-4	51	73	73	49	9 (Rw 34)	48	68	68	44	4 (Rw 34)
	G2-1	54	74	71	47	7 (Rw 32)	53	69	67	43	3 (Rw 33)
	G2-2	53	71	68	44	4 (Rw 29)	51	66	63	39	-
	G3	57	72	70	46	6 (Rw 31)	55	68	66	42	2 (Rw 32)
Low density residential	H	50	66	59	35	-	46	60	56	32	-
	I	53	67	63	39	-	50	61	57	33	-
	J0	52	69	67	43	3 (Rw 28)	50	63	62	38	-
	J1	50	67	61	37	-	49	61	57	33	-
	J2	51	63	62	38	-	49	58	57	33	-
	J3	48	65	62	38	-	47	59	57	33	-
	K	48	56	52	28	-	48	53	51	27	-

Note 1: Internal noise levels cannot be accurately determined without knowing the exact construction of the building's façade. The internal noise level has been estimated assuming the façade provides an indicative noise reduction of 24 dBA and is considered representative of a masonry or lightweight wall with standard 5 mm thick glazing.

Acceptability of future development noise levels

Indicative façade construction considerations

The acceptability of the future transport noise levels would be dependent on the construction of individual buildings along the busy roads to assess whether noise levels exceed 35 dBA in bedrooms during the night at 40 dBA for other habitable rooms during the day (T&I SEPP internal noise levels).

It is not possible to assess internal noise levels without understanding the construction of the building envelope for every individual building. As such, indicative façade construction categories have been used to identify a qualitative risk level for affected facades within Westmead South.

Façade noise maps in this report present the future modelled noise levels at future buildings and have been colour coded based on indicative façade construction considerations (see Table 4.2 and Table 4.3) and Building Code of Australia (BCA) ventilation requirements.

Table 4.2 Indicative façade construction considerations

Indicative category	Construction type	Indicative glazing	Consider BCA ventilation requirements[1]
Category A	Standard construction	5 mm thick glazing	-
Category B	Standard construction	5 mm thick glazing	Yes
Category C	Acoustic treatment	6.38 mm laminated glazing	Yes
Category D	Acoustic treatment	10.38 mm laminated glazing	Yes
Category E	Acoustic treatment	12.5 mm Vlam Hush glazing	Yes
Category F	Acoustic treatment	Specialised double glazing	Yes

1) If internal noise levels with windows or doors open exceed the criteria by more than 10dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also to meet the ventilation requirements of the Building Code of Australia

Day period noise levels

Residential buildings where daytime noise levels are $L_{Aeq(15hour)}$ 61 or greater are shown in Figure 4.8 and have been considered medium or high risk. The colour code legend for the façade noise maps is presented in Table 4.3 (day period).

Table 4.3 Façade noise map legend – Day period (habitable rooms other than bedrooms)

Risk level	None		Low		Medium		Risk	
Noise level	<= 52	>52 & <= 55	>55 & <= 58	>58 & <= 61	>61 & <= 64	>64 & <= 67	>67 & <= 70	>70
Colour code	A	A	B	B	C	D	E	F

The results of the risk analysis indicate that:

– sensitive receivers along Great Western Highway, Hawkesbury Road, Bridge Road and Alexandra Avenue in would require special acoustic consideration to ensure the T&I SEPP noise levels could be achieved. An acoustic assessment during the DA stage for development along these roads would be a **mandatory** requirement under the requirements of the T&I SEPP.

– sensitive receivers along Good Street, Pye Street, Amos Street and sections of Houison Street and Hassall Street would likely require more than standard construction methods to achieve the day period internal noise levels in the T&I SEPP. An acoustic assessment is **recommended** during the DA stage for future development.

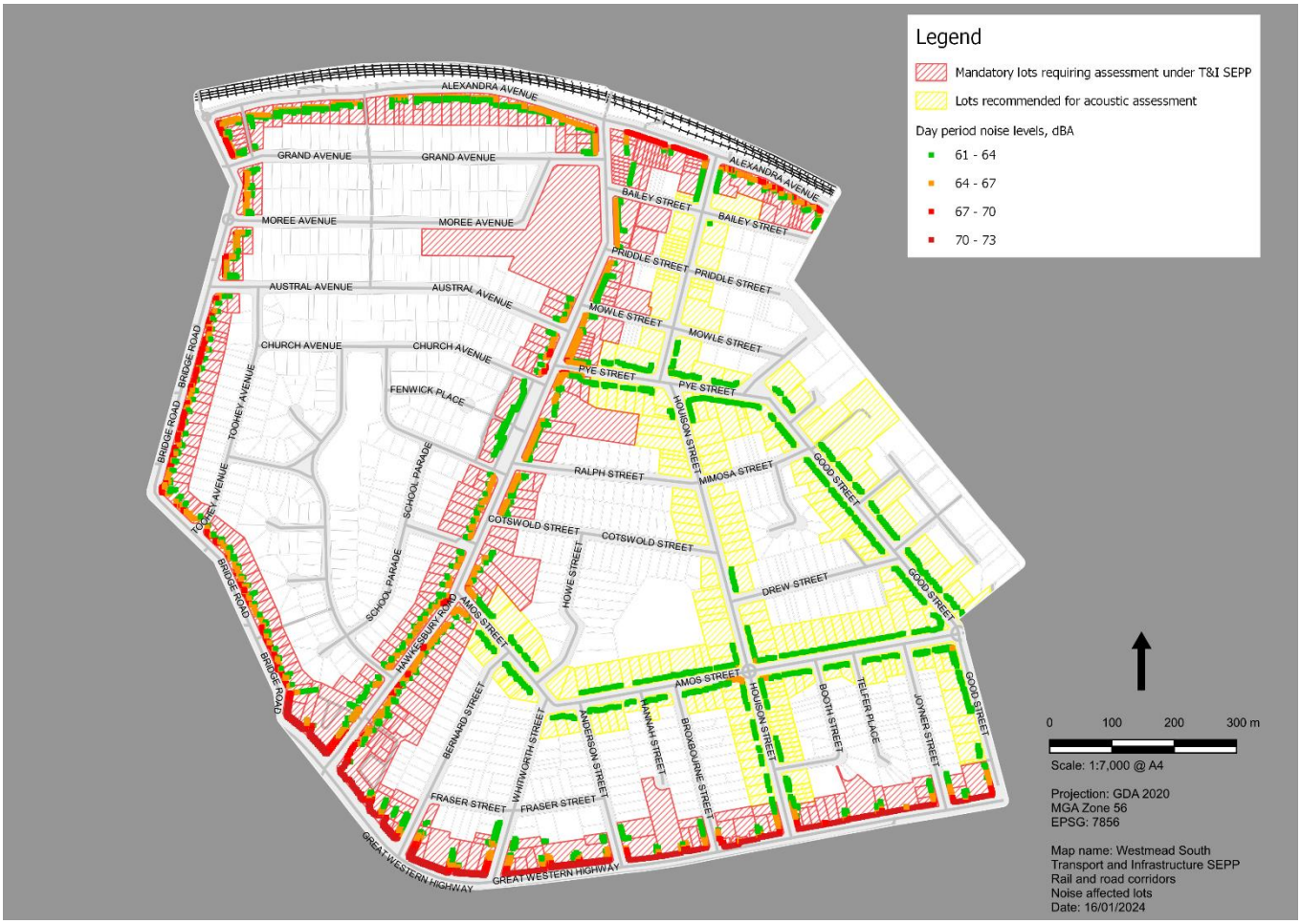


Figure 4.8 Façade noise levels $L_{eq(15hour)}$ 61 dBA or greater (more than standard construction required)

Night period noise levels

Residential buildings where night period noise levels are $L_{Aeq(9hour)}$ 55 or greater are shown in Figure 4.9 and are considered to be medium or high risk. The colour code legend for the façade noise maps is presented in Table 4.4 (night period).

Table 4.4 Façade noise map legend – Night period (bedrooms)

Risk level	**None**		**Low**		**Medium**		**High**	
Noise level	<= 49		>49 & <= 52	>52 & <= 55	>55 & <= 58	>58 & <= 61	>61 & <= 64	>64 & <= 67
Colour code	A	A	B	B	C	D	E	F

The results of the risk analysis indicate that:

– sensitive receivers along Great Western Highway, Hawkesbury Road, Bridge Road and Alexandra Avenue in would require special acoustic consideration to ensure the T&I SEPP night noise levels could be achieved. An acoustic assessment during the DA stage for development along these roads would be a **mandatory** requirement under the requirements of the T&I SEPP.

– sensitive receivers along Good Street, Pye Street, Amos Street and sections of Houison Street and Hassall Street would likely require more than standard construction methods to achieve the night period internal noise levels in the T&I SEPP. An acoustic assessment is **recommended** during the DA stage for future development.

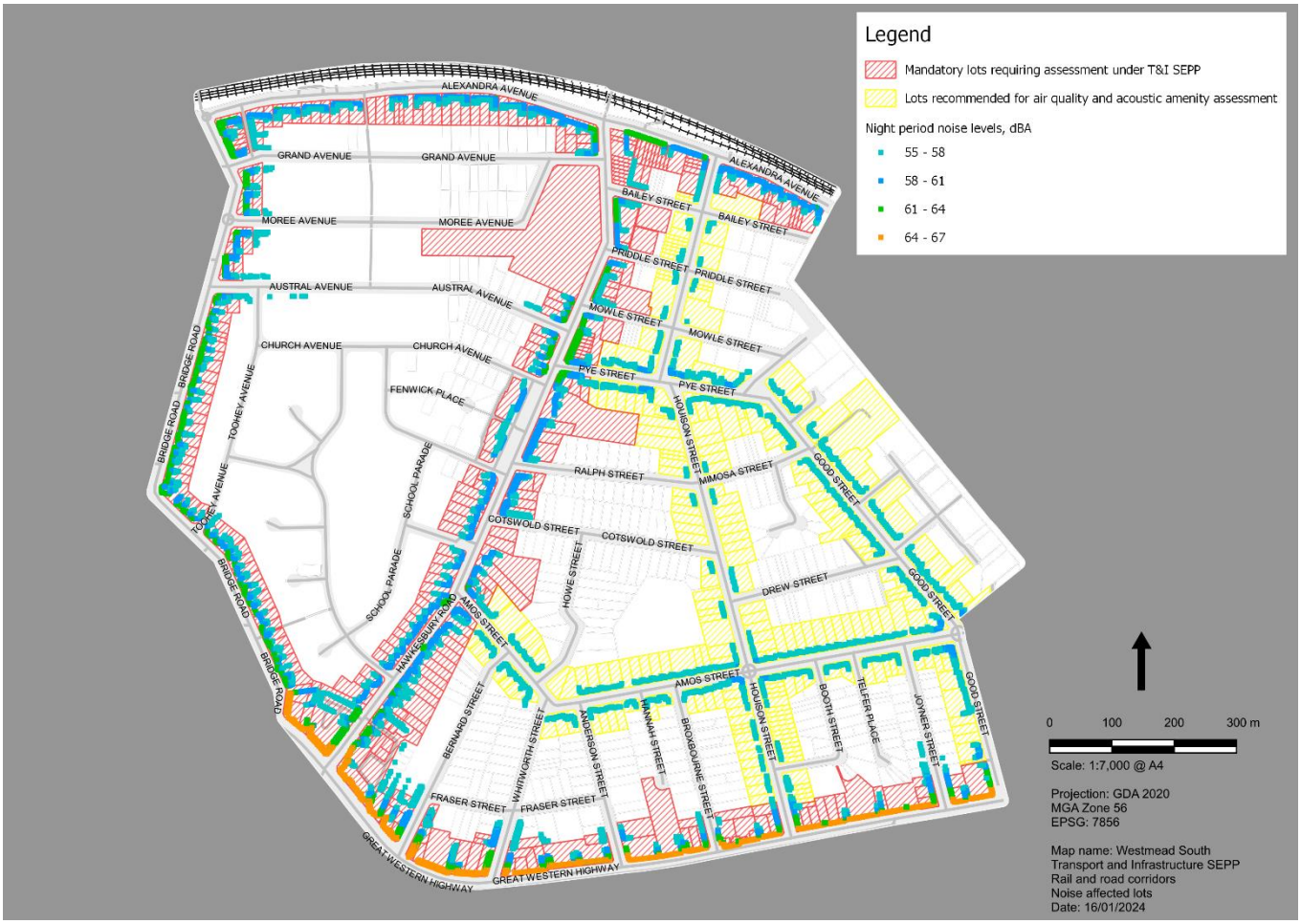


Figure 4.9 Façade noise levels $L_{eq(9hour)}$ 55 dBA or greater (more than standard construction required)

3D façade noise maps along key roads

Façade noise maps along key roads within Westmead South are provided below:

– Mixed use / high density residential (Figure 4.10 and Figure 4.11)
– Residential flat buildings (Figure 4.10Figure 4.12 and Figure 4.13)
– Low density residential (Figure 4.14 and Figure 4.15)

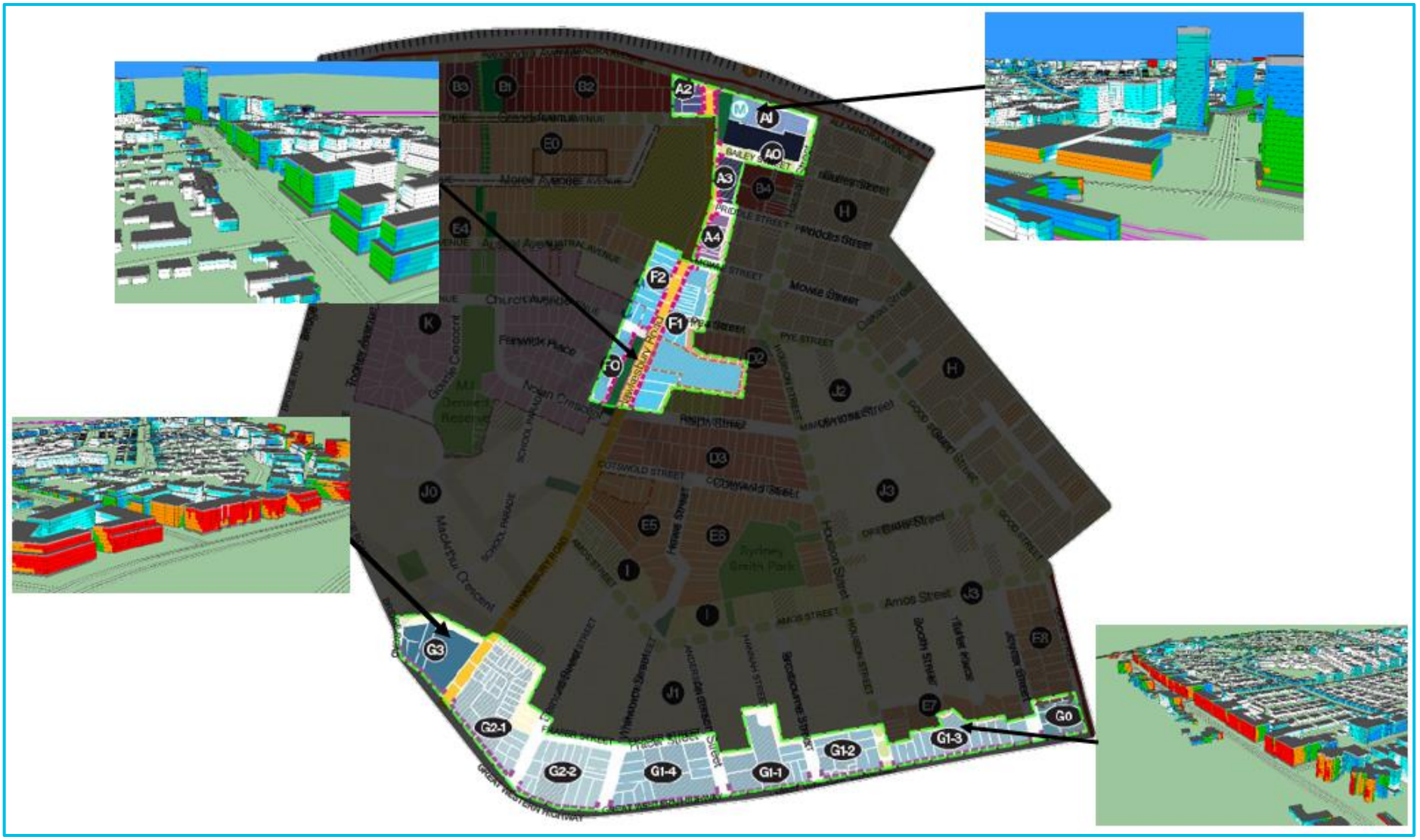


Figure 4.10 ***Façade noise level summary, day 15hr – Mixed use/High density areas***

Risk level	**None**		**Low**		**Medium**		**Risk**	
Noise level (day)	<= 52	>52 & <= 55	>55 & <= 58	>58 & <= 61	>61 & <= 64	>64 & <= 67	>67 & <= 70	>70
Colour code	A	A	B	B	C	D	E	F

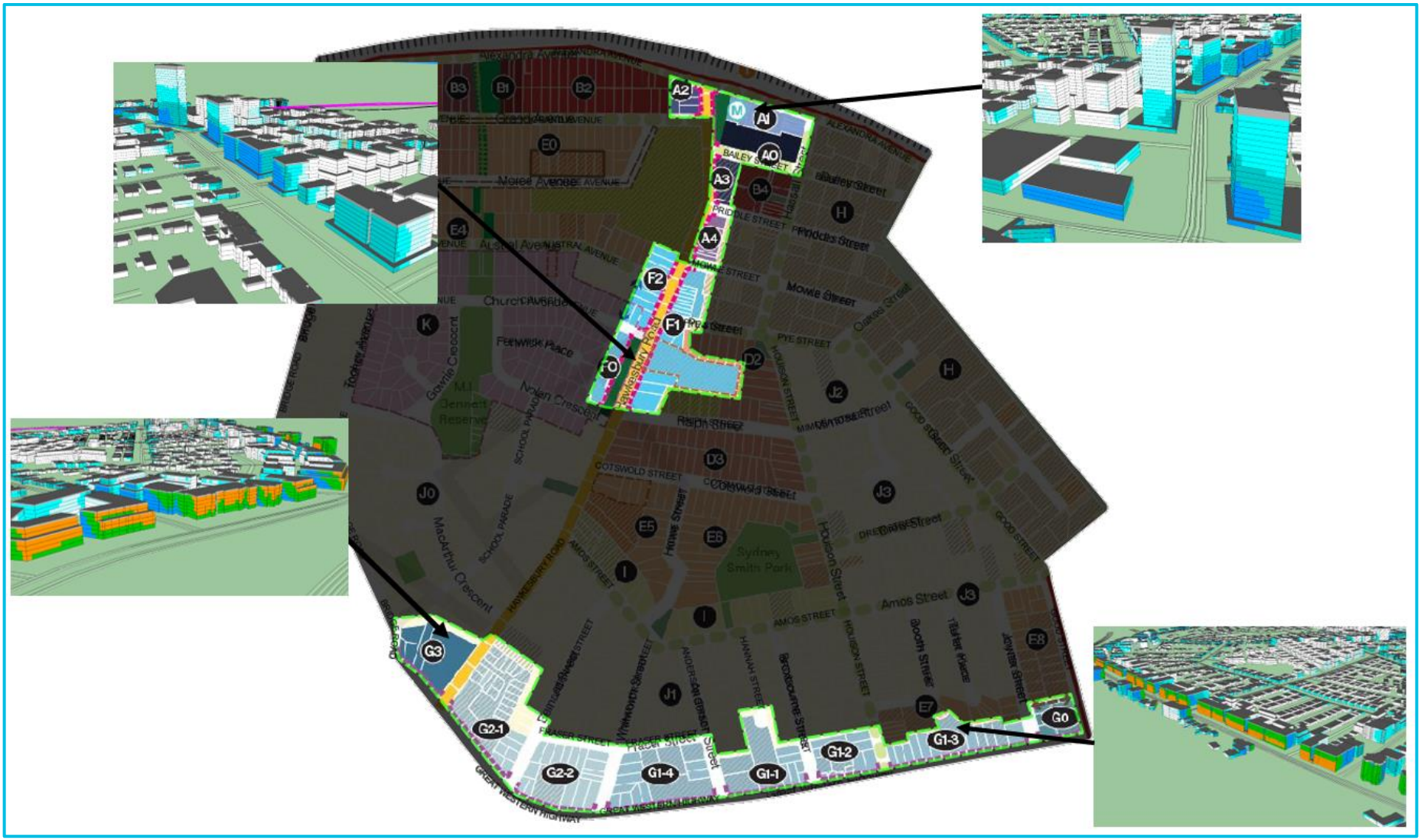


Figure 4.11 Façade noise level summary, night 9hr – Mixed use/High density areas

Risk level	None		Low		Medium		Risk	
Noise level (night)	<= 49		>49 & <= 52	>52 & <= 55	>55 & <= 58	>58 & <= 61	>61 & <= 64	>64 & <= 67
Colour code	A	A	B	B	C	D	E	F

Figure 4.12 Façade noise level summary, day 15hr – Residential flat buildings

Risk level	None		Low		Medium		Risk	
Noise level (day)	<= 52	>52 & <= 55	>55 & <= 58	>58 & <= 61	>61 & <= 64	>64 & <= 67	>67 & <= 70	>70
Colour code	A	A	B	B	C	D	E	F

Figure 4.13 Façade noise level summary, night 9hr – Residential flat buildings

Risk level	None		Low		Medium		Risk	
Noise level (night)	<= 49		>49 & <= 52	>52 & <= 55	>55 & <= 58	>58 & <= 61	>61 & <= 64	>64 & <= 67
Colour code	A	A	B	B	C	D	E	F

Figure 4.14 Façade noise level summary, day 15hr – Low density residential

Risk level	None		Low		Medium		Risk	
Noise level (day)	<= 52	>52 & <= 55	>55 & <= 58	>58 & <= 61	>61 & <= 64	>64 & <= 67	>67 & <= 70	>70
Colour code	A	A	B	B	C	D	E	F

Figure 4.15 Façade noise level summary, night 9hr – Low density residential

Risk level	None		Low		Medium		Risk	
Noise level (night)	<= 49		>49 & <= 52	>52 & <= 55	>55 & <= 58	>58 & <= 61	>61 & <= 64	>64 & <= 67
Colour code	A	A	B	B	C	D	E	F

4.2 Air quality assessment

Air quality modelling methodology

Dispersion modelling was undertaken using the Graz Lagrangian Model (GRAL) to predict concentrations of key air quality pollutants from road vehicle emissions at existing buildings within Westmead South. Additional modelling methodology detail is outlined in Appendix D.

Assessed pollutants

The major vehicle pollutants include products of combustion, such as carbon monoxide (CO), particulate matter (PM), oxides of nitrogen (NO_x), and volatile organic compounds (VOCs). The human health effects of these air pollutants range from mild airway irritations to major organ damage. Many of the emissions from motor vehicles react together and with pollutants from other sources to form secondary pollutants, such as photochemical oxidants (ozone; O_3), which can also have significant effects (Main Roads, 2004).

For the purpose of this assessment, emission estimation and dispersion modelling of NO_2 and $PM_{2.5}$ only have been undertaken. Based on past experience of local road projects, NO_2 or $PM_{2.5}$ are typically the pollutants with the highest impact with respect to the criteria, and thus are considered the constraining pollutants. Impacts of CO, SO_2 and VOCs are not typically the constraining pollutants due to the emissions from road traffic and background concentrations being comparatively lower. The air assessment for the project estimates pollution generated by vehicles using projected traffic volumes and vehicle emission rates as inputs to an air dispersion model.

Vehicle emission rates

The vehicle emission factors were calculated from outputs from the *Computer program to calculate emissions from road transport* (COPERT 2014), using the NSW fleet characteristics. The amount of pollutant emitted from a vehicle depends on the type of vehicle, fuel type (petrol, diesel or LPG), and driving conditions (grade of slope, road speed, congestion and road conditions).

The COPERT NSW input file includes the NSW 2010 fleet characteristics such as vehicle type, technology and fuel type. NSW-specific population of each vehicle type and average mileage are also included in this input file. Due to the absence of a reliable current and future fleet distribution and the complexity in forecasting future fleets, the 2010 fleet distribution has been adopted for this study. Improvements to vehicles and the increasing uptake of electric vehicles are therefore not taken into account, and estimated emission rates and predicted impacts are conservative.

Light vehicles and heavy vehicles were run separately so that the link-specific light and heavy vehicle split could be applied. The light vehicle fleet is made up of petrol and diesel passenger cars (PCs) and light commercial vehicles (LCVs). The light vehicle fleet distribution derived from the NSW COPERT input file is presented in Table 4.5.

Table 4.5 COPERT-derived light vehicle fleet distribution

Vehicle type	Fleet proportion
PC petrol	76%
PC diesel	5%
LCV petrol	8%
LCV diesel	11%

COPERT was run for the appropriate road speeds to provide the tonnes emitted per year for each vehicle type and pollutant. These outputs were then used to calculate an emission factor for each pollutant, as presented in Table 4.6.

Table 4.6 COPERT-derived emission factors

Pollutant	Vehicle type	Emission factors (g/km/veh)				
		20 km/hr	40 km/hr	50 km/hr	60 km/hr	80 km/hr
NO_2	Light Vehicles	0.124	0.084	0.070	0.065	0.069
	Heavy Vehicles	1.372	0.991	0.873	0.792	0.737
$PM_{2.5}$	Light Vehicles	0.044	0.035	0.031	0.028	0.025
	Heavy Vehicles	0.400	0.274	0.226	0.190	0.149

Current hourly traffic volumes have been estimated on observed data surveyed by Traffic Survey between 2 August 2023 and 9 August 2023 and supplied by SCT consulting. These data were then adjusted to take into account the expected increase in traffic based on the additional residences in the masterplan to estimate the vehicle numbers for 2041, which have been used to estimate future emissions. Figure 4.16 shows an example of diurnal profiles, using data forecasted for Hawkesbury Road. The plot shows that the estimated light vehicle traffic volumes have a morning and evening peak while heavy vehicle traffic is consistent throughout the day with very low levels at night. Details of hourly traffic volumes used for modelling are provided in Appendix D-1. The hourly diurnal emission profiles were then calculated for each link based on the hourly traffic counts and the relevant emission factor based on speed for each link.

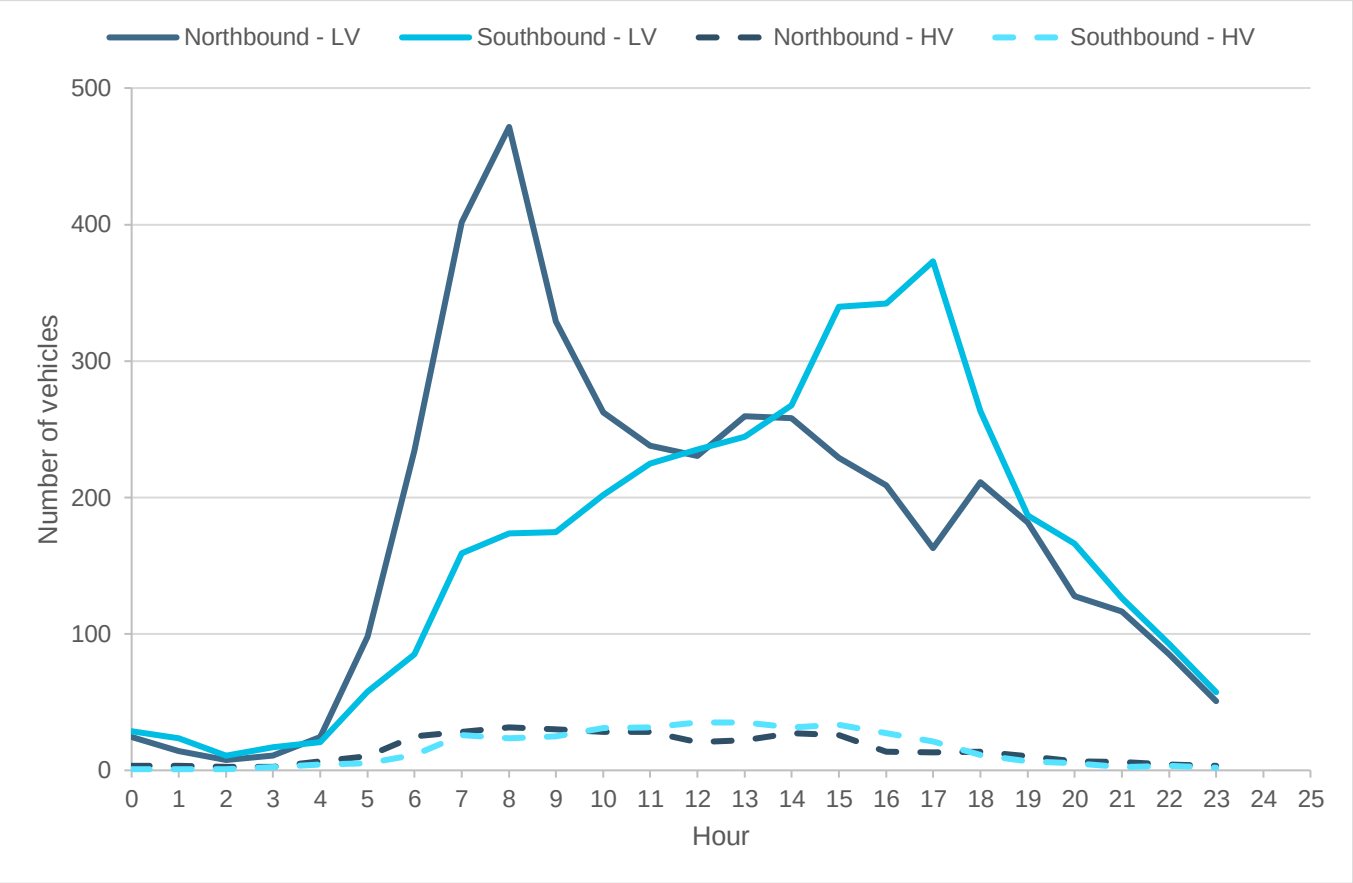


Figure 4.16 Forecasted hourly vehicle numbers on Hawkesbury Road (2041)

Locomotive emission rates

The locomotive emission factors were based on those provided in the *Diesel Locomotive Fuel Efficiency & Emissions Testing Report* (ABMARC, 2016). Average locomotive emission rates (93 class-9317) were adopted. The amount of pollutant emitted from a locomotive depends on the notch used. Emission rates are provided in g/kWhr, and were converted to notches based on the conversion rates provided in *Quantification and Dispersion Modelling of Diesel Locomotive Emissions* (Lilley, 1996). The adopted emission rates are presented in Table 4.7.

A notch of three has been assumed for all locomotives travelling through the assessed portion of the rail line, with a speed of 30 km/hr.

Table 4.7 Locomotive emission factors

Notch	NO_X (g/s/locomotive)	$PM_{2.5}$ (g/s/locomotive)
Idle	0.09	0.002
1	1.05	0.011
2	1.58	0.014
3	4.10	0.038
4	4.63	0.040
5	5.33	0.045
6	7.00	0.054
7	9.06	0.064
8	8.17	0.063

Air quality objectives

The *National Environment Protection (Ambient Air Quality) Measure* (Air NEPM) and the *National Environment Protection (Air Toxics) Measure* (Toxics NEPM) were developed to provide benchmark standards for ambient air quality to allow for the adequate protection of human health and well-being (National Environment Protection Council, 2021). These measures provide criteria for a range of pollutants and VOCs that would be expected from vehicle emissions. Table 4.8 provides a summary of the air quality objectives for key pollutants of concern, nitrogen dioxide (NO_2) and particulate matter ($PM_{2.5}$). Objectives for $PM_{2.5}$ are expected to change from 1 January 2025 as outlined in the Air NEPM and are shown in brackets beside the current objective.

Table 4.8 Air quality assessment objectives

Pollutant	Averaging period	Statistic	Maximum concentration	
			$\mu g/m^3$	ppm
$PM_{2.5}$	1 day	Maximum	25 (20)	-
	1 year	Average	8 (7)	-
NO_2	1 hour	Maximum	164	0.08
	1 year	Average	31	0.015

Evaluation of future air quality levels

Dispersion modelling using the GRAL model was undertaken to determine concentrations of $PM_{2.5}$ and NO_2 at receivers representing the future (2041) built form of the area. GRAL modelling was completed using a 1-hour modelling time step, and was used to predict concentrations for four levels (heights) above the ground at the receiver locations. Maximum short-term (hourly and daily for NO_2 and $PM_{2.5}$ respectively) and annual averages at the first floor, as a worst-case, for each pollutant have been analysed.

The modelled distribution of NO_2 and $PM_{2.5}$ exposure in the community due to the future road traffic volumes are represented in the Box and Whisker Plots Figure 4.17, Figure 4.18, Figure 4.19 and Figure 4.20. The plots, for each pollutant and statistic, show the range of predicted concentrations which are predicted at all modelled receiver buildings for each land use in the precinct. The worst impacted land use was mixed use/high rise areas. Results for this land use have been further broken down into the masterplan development areas. These results represent the worst impacted façade per building. The number of storeys and building category (e.g. mixed use or residential) as presented in Table 3.2 should be taken into account to gain an understanding of overall impact.

Predicted $PM_{2.5}$ concentrations are below the both the annual average (of 8 µg/m^3) and the 24-hour maximum criteria (of 25 µg/m^3) at all receptor locations.

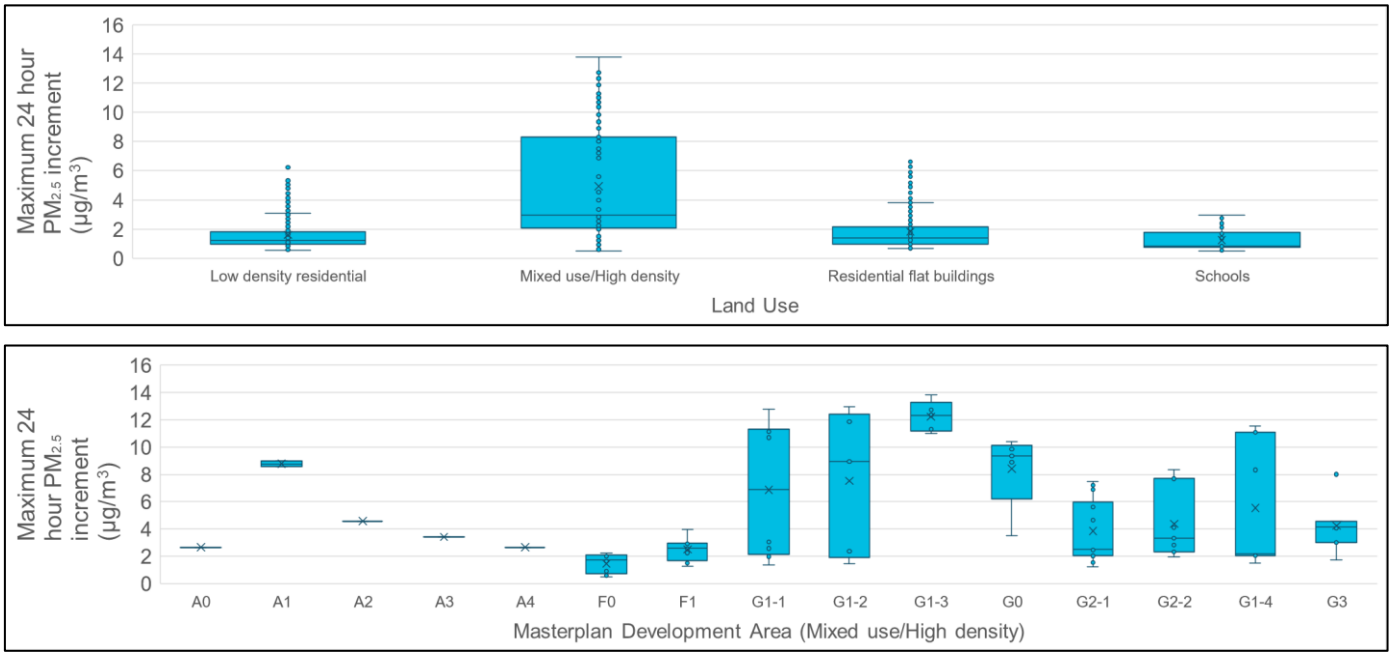


Figure 4.17 ***Maximum 24 hour $PM_{2.5}$ concentrations from future road traffic and locomotive emissions by land use (top) and by masterplan development area for mixed use/high density areas (bottom)***

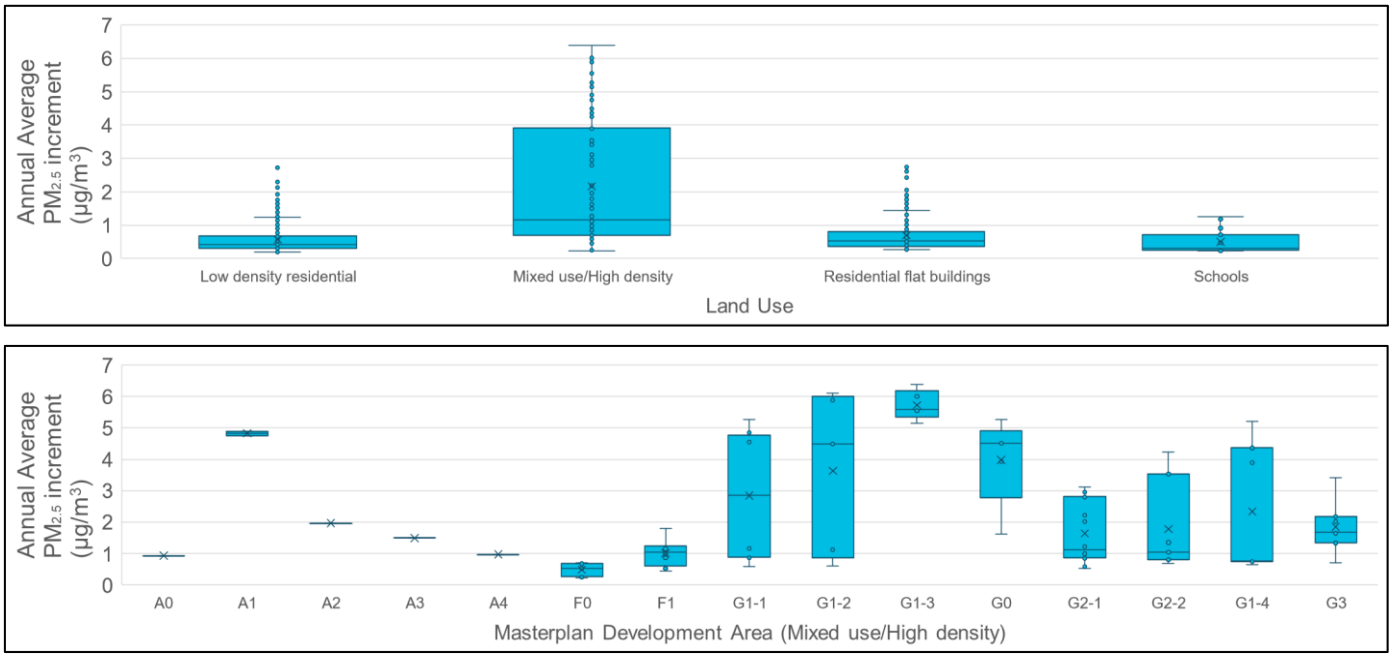


Figure 4.18 ***Annual average $PM_{2.5}$ concentrations from future road traffic and locomotive emissions by land use (top) and by masterplan development area for mixed use/high density areas (bottom)***

One sensitive receptor is impacted by NO_2 concentrations above the 1-hour maximum criterion (of 164 µg/m^3). This ground-level receptor is located adjacent to the Great Western Highway and Joyner Street.

Exceedances of both NO_2 criteria were also observed at the Westmead station, however this is not considered a sensitive receptor due to the short term exposure expected as people move through the station.

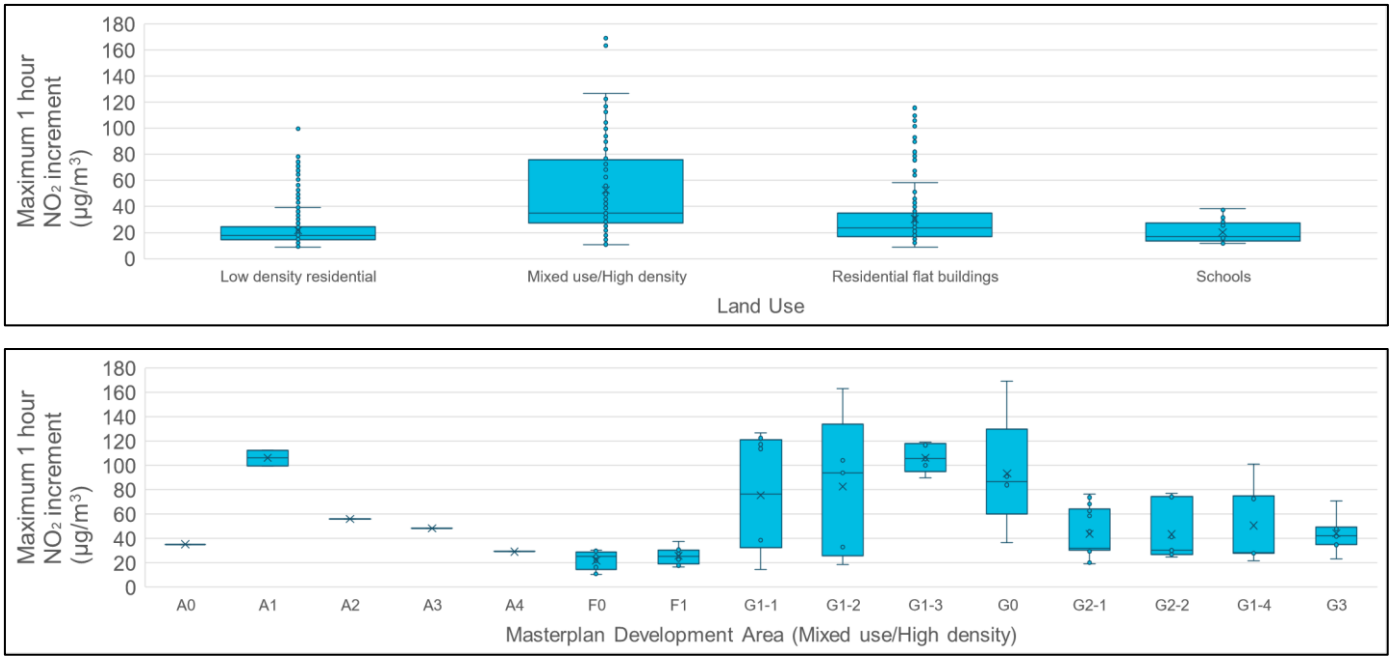


Figure 4.19 ***Maximum 1 hour NO_2 concentrations from future road traffic and locomotive emissions by land use (top) and by masterplan development area for mixed use/high density areas (bottom)***

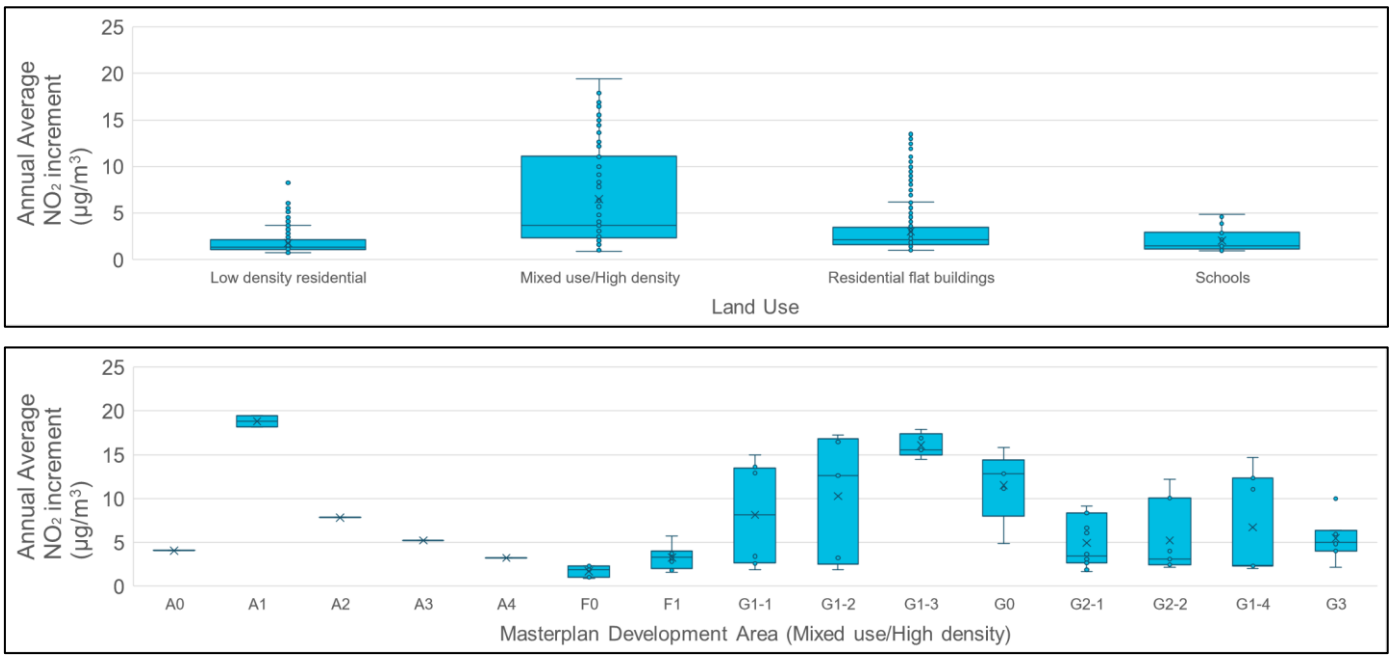


Figure 4.20 ***Annual average NO_2 concentrations from future road traffic and locomotive emissions by land use (top) and by masterplan development area for mixed use/high density areas (bottom)***

Receptors at which increased concentrations are observed are generally near to major intersections and roads with high traffic volumes. Additionally, predicted impacts are considered highly conservative due to the adopted emission factors. Vehicle emission factors were calculated based on a 2010 vehicle fleet. Actual future emissions are considered likely to be less than this due to improvement of the vehicle fleet (including upgraded standards for new cars) and the increasing uptake of electric vehicles, which do not emit NO_2. Recommendations have been provided for these receptors in Section 5 to further limit impacts of road and locomotive emissions.

The Air NEPM and Approved methods provide air quality objectives for both short-term and long-term averaging periods for both $PM_{2.5}$ and NO_2. Short-term air quality objectives are provided to mitigate against the potential for acute air quality impacts to be experienced within the community, whereas long-term air quality objectives are provided to mitigate against the potential for long-term, chronic air quality impacts.

When interpreting assessment results, receivers experiencing the highest annual average concentrations are those which are expected to have comparatively consistent exposure to air pollutants. It is considered that assessment of annual average impacts is the most effective method in the context of urban design activities.

As discussed in the Stage 1 report, background air quality in Sydney fluctuates year on year due to meteorological and other natural causes as well as evolving industrial and transport emissions which places challenges on conducting cumulative assessment for a representative modelled year. To demonstrate this variability, an average incremental value for each of the main land uses in the precinct has been cumulatively assessed for the previous six years (2017-2022) and is shown in Figure 4.21 and Figure 4.23 for $PM_{2.5}$ and NO_2 respectively.

Areas of mixed use/high density are predicted to be worst impacted for both pollutants. Average incremental values for each development area of this land use are shown in Figure 4.22 and Figure 4.24 for $PM_{2.5}$ and NO_2 respectively. These plots demonstrate that while incremental concentrations may be below the Air NEPM criteria, years of poor ambient air quality may still lead to non-compliance of the Air NEPM objectives.

Results demonstrate that the ambient air quality (background) is the predominant contributor to cumulative air quality across most masterplan development areas.

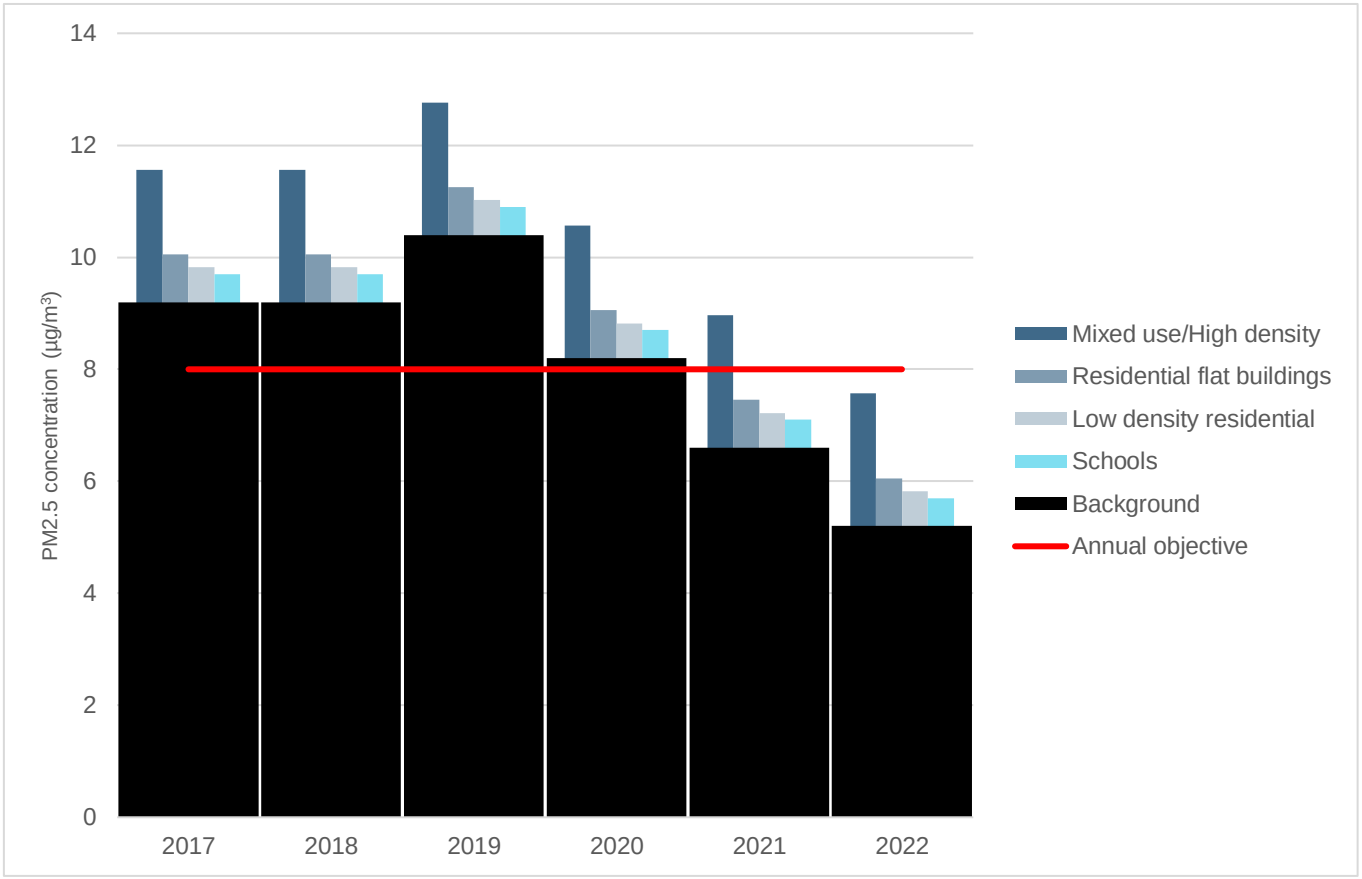


Figure 4.21 Cumulative assessment of annual average $PM_{2.5}$ by land use

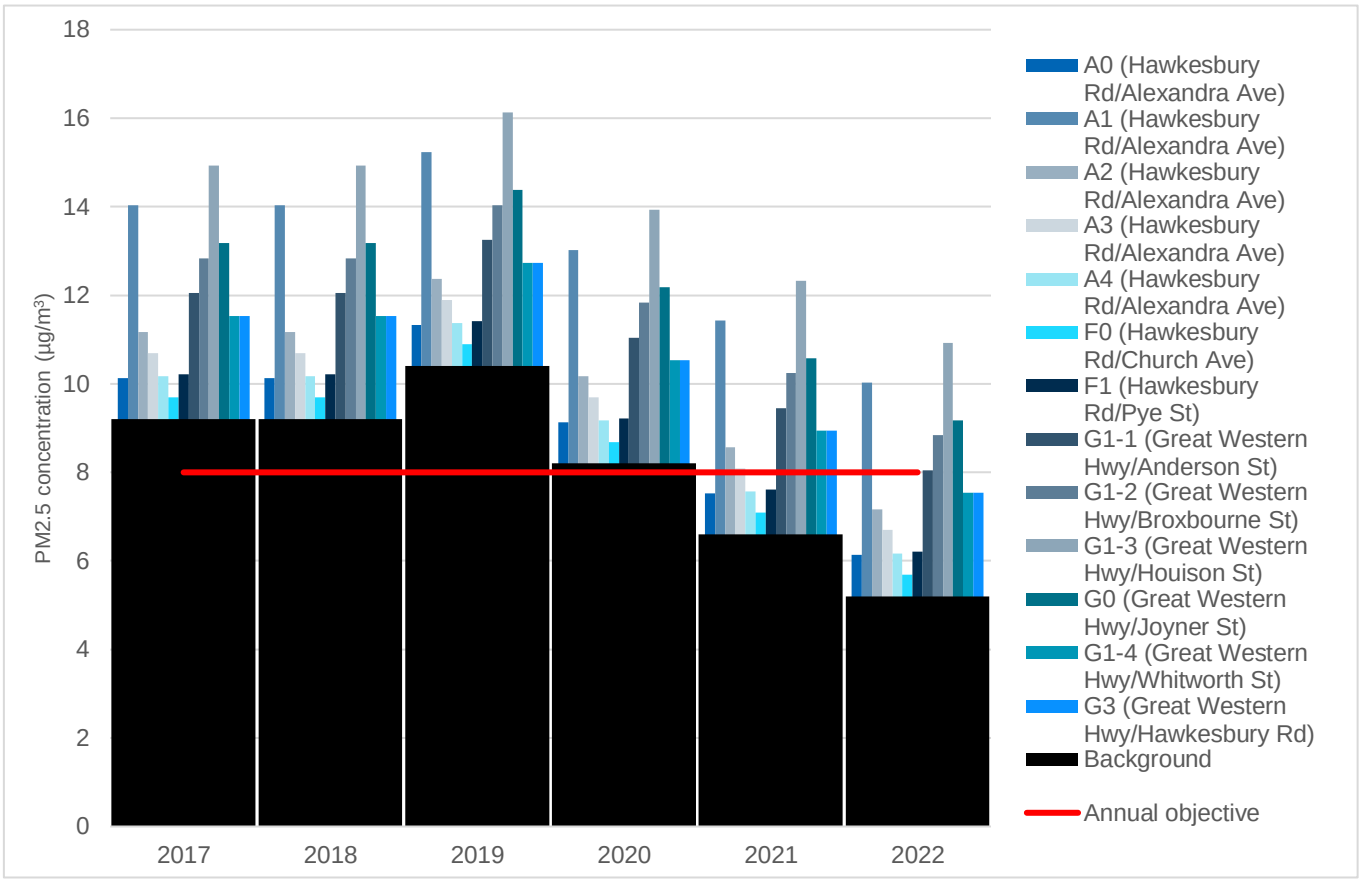


Figure 4.22 ***Cumulative assessment of annual average $PM_{2.5}$ for mixed use / high density development areas***

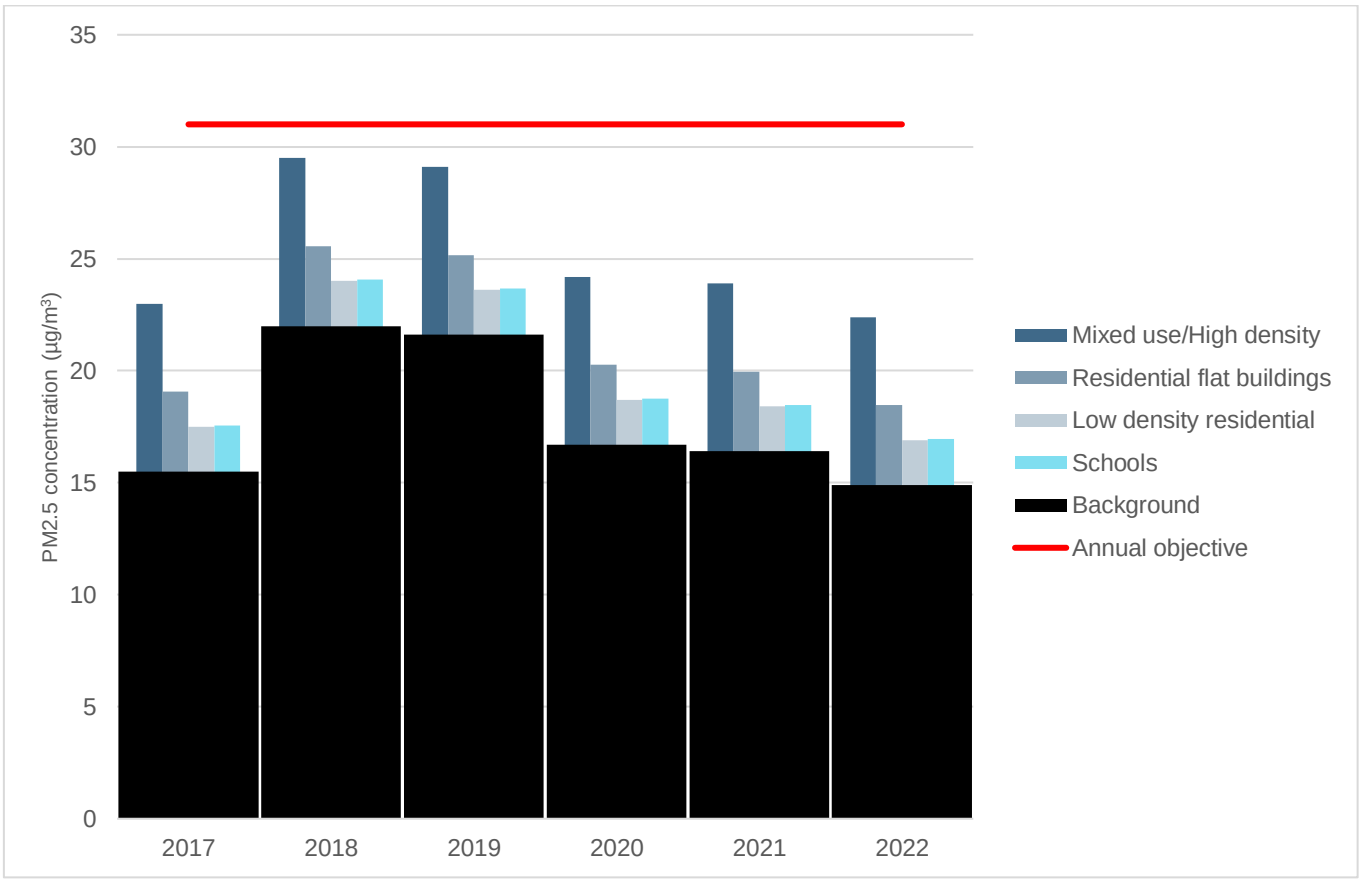


Figure 4.23 ***Cumulative assessment of annual average NO_2 by land use***

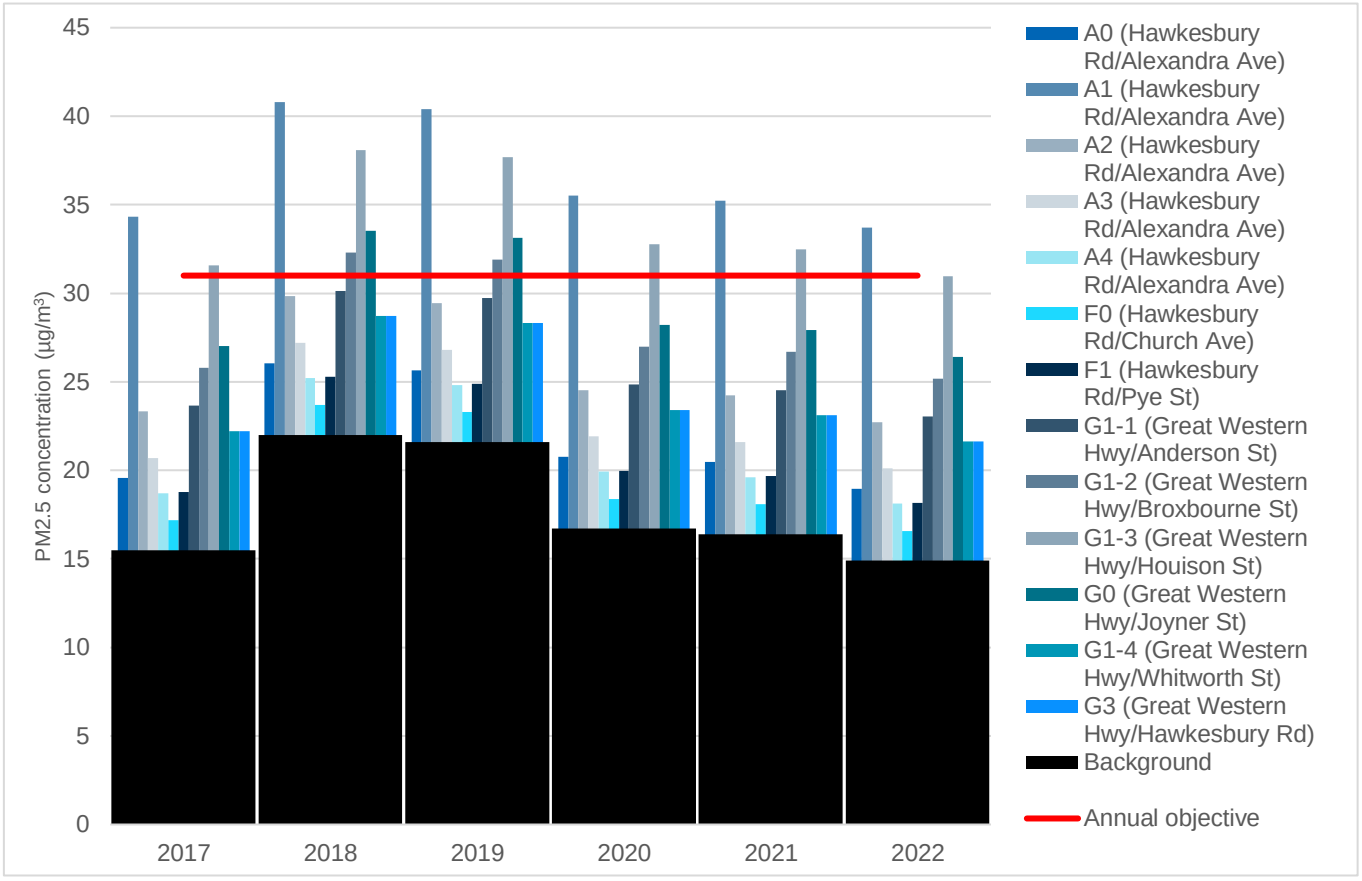


Figure 4.24 Cumulative assessment of annual average NO_2 for mixed use / high density development areas

Transport air quality risk assessment

As discussed above, there are instances where the ambient air quality exceeds NEPM objectives and therefore an alternate methodology has been developed to assess the health risk of incremental emissions from the assessed roads.

A Framework has been developed based on a review of the background air quality available at the Parramatta North AQMS and the methodology proposed in *An Australian incremental guideline for particulate matter (PM2.5) to assist in development and planning decisions* (Capon & Wright, 2019). Based on this methodology, a level of 1.8 µg/m^3 has been adopted as the level at which the risk of impacts to health due to incremental $PM_{2.5}$ is high and cumulative levels are likely to exceed the objectives of the NEPM. A similar approach has been taken for annual NO_2 with a high-risk level of 15 µg/m^3 adopted. At this level it is expected that mitigation would be required (no sensitive receptors exposed to unmitigated air).

The locations of high-risk areas, as defined above, can be seen in red on Figure 4.25, Figure 4.26 and Figure 4.27 for $PM_{2.5}$ at the ground and third floors and NO_2 at the ground floor, respectively.

Additionally, low and medium risk categories have been defined as being exposure of up to 33% and 66% of the adopted objective respectively. Table 4.9 outlines the adopted risk categories and objective levels for each pollutant. Receivers exposed to levels less than 33% of the objective are deemed to be very low risk.

For areas where large numbers of medium and high-risk receivers are present design considerations, such as those provided in Section 5 of the Stage 1 report, should be considered. The maps demonstrate the benefit of maximising the distance between the road and ventilation pathways which can be achieved by setting the structure back from the road or siting mechanical ventilation air inlet ports and natural ventilation windows/doors on facades not directly adjacent to the road.

The results of the risk assessment indicate that:

– High risk receptors occur at the lower levels (below the third floor) of buildings along Bridge Road, Great Western Highway, Hawkesbury Road (south of intersection with Amos St), Hawkesbury Road (north of intersection with Bailey St) and Alexandra Avenue and would require special design considerations to ensure air quality objectives are complied with. Consideration of air quality impacts would be a **mandatory** requirement under the requirements of the T&I SEPP.
– High risk receptors occur at upper levels (above third floor) of buildings along Great Western Highway, these would require special design considerations to ensure air quality objectives are complied with. Consideration of air quality impacts would be a **mandatory** requirement under the requirements of the T&I SEPP.
– Sensitive receivers along Amos Street and Good Street (south of the intersection with Amos St) may require special design considerations if residential buildings are proposed on the ground and first floors. Consideration of air quality impacts is **recommended** during the DA stage for future development.

Table 4.9 Air quality risk categories and map legend

Risk level	Very low	Low	Medium	High
Colour code				
$PM_{2.5}$ concentration (µ/m³)	<= 0.6	>0.6 & <= 1.2	>1.2 & <= 1.8	>1.8
NO_2 concentration (µ/m³)	<= 5	>5 & <= 10	>10 & <= 15	>15

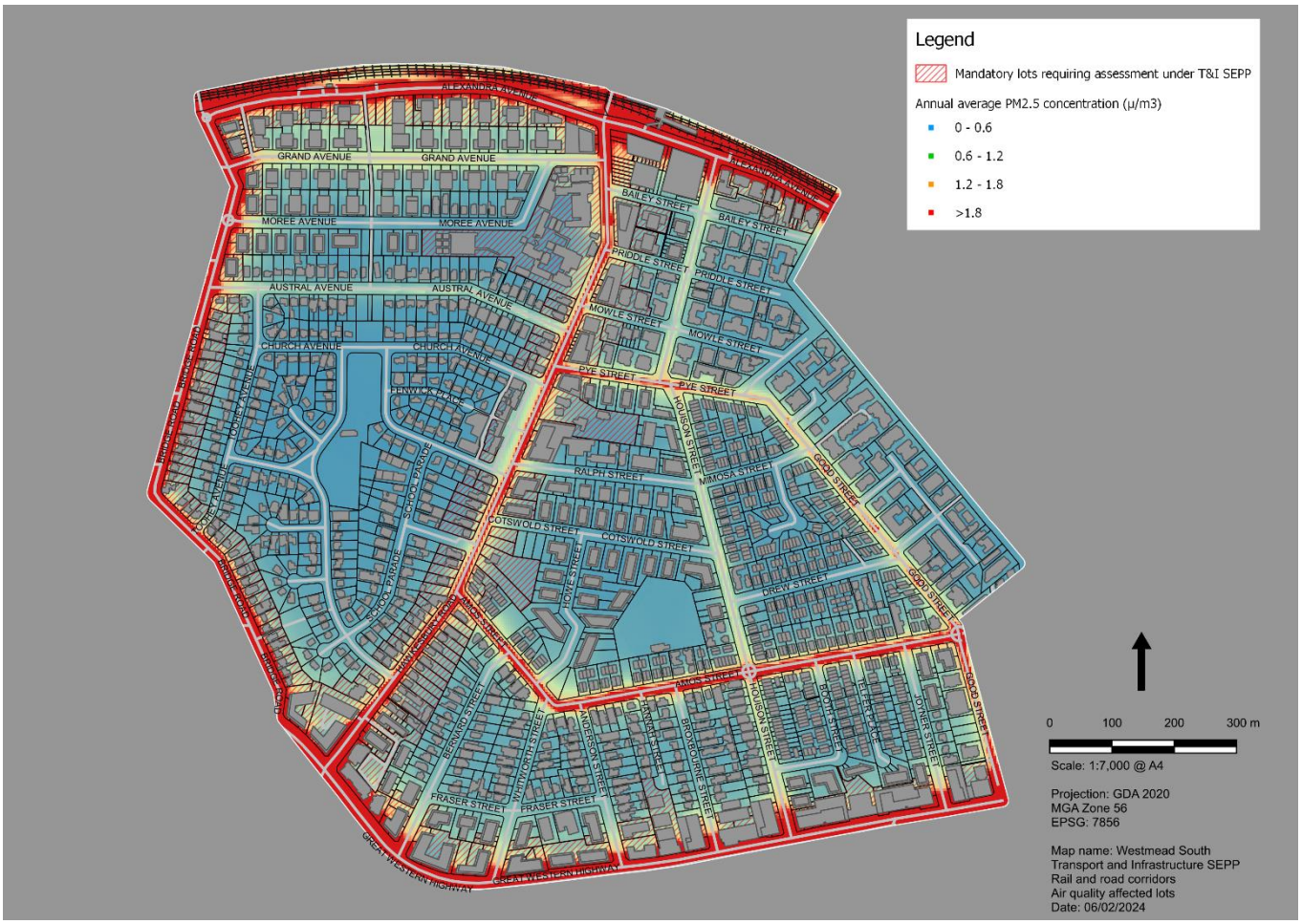


Figure 4.25 Annual risk level of exceedance of $PM_{2.5}$ objectives – Ground floor

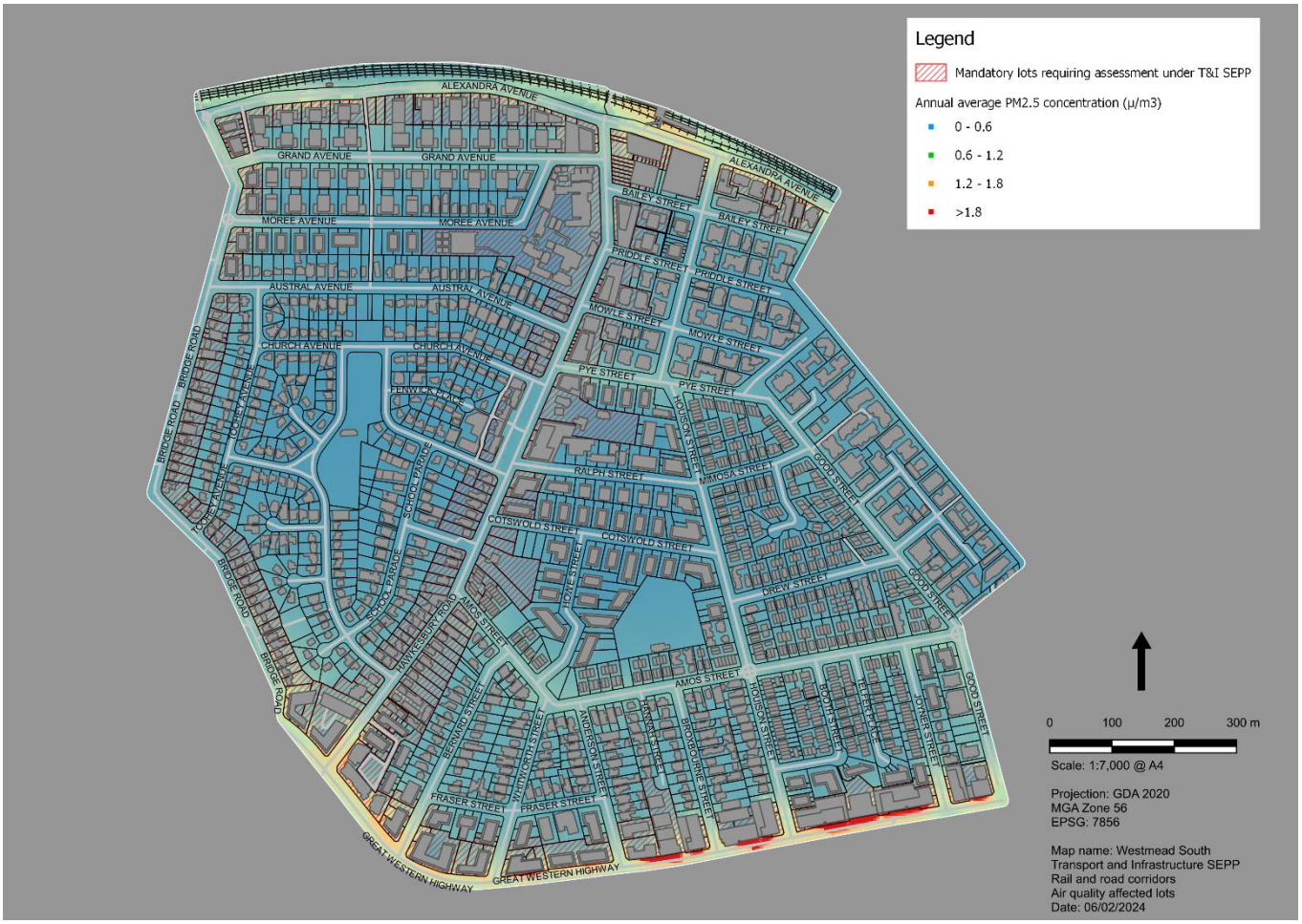


Figure 4.26 Annual risk level of exceedance of $PM_{2.5}$ objectives – Third floor

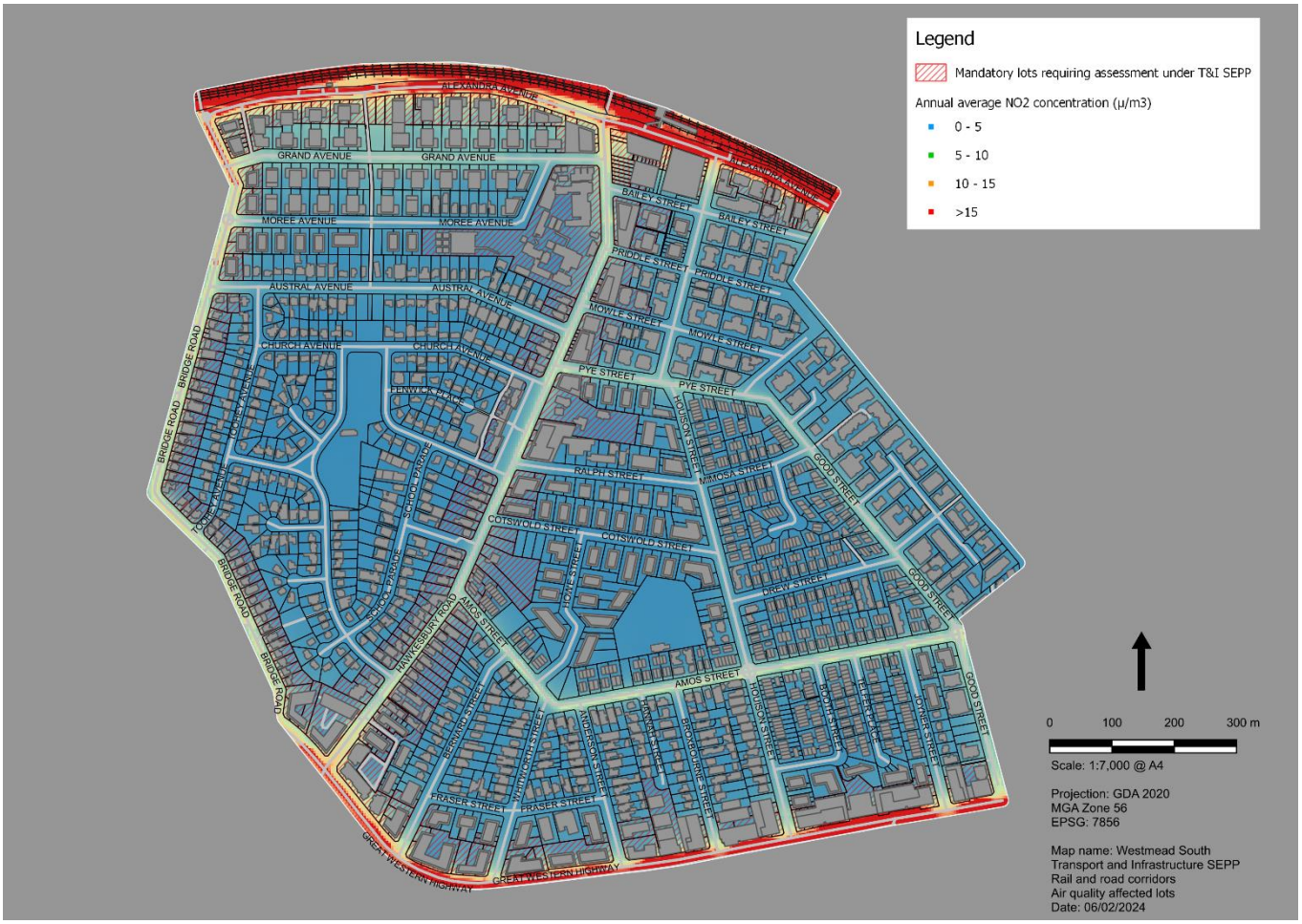


Figure 4.27 Annual risk level of exceedance of NO_2 objectives – Ground floor

Recommended planning controls

Recommendations for DCP planning controls based on the outcomes of the acoustics and air quality impact assessments

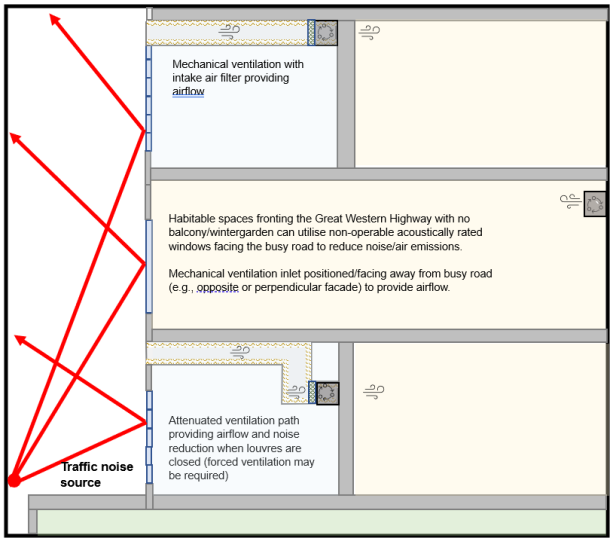
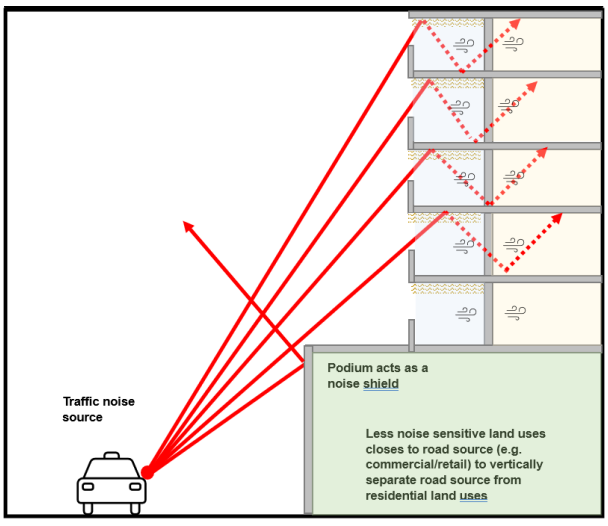
5. Recommended DCP planning controls

Draft planning controls recommended for inclusion in the Westmead South Development Control Plan (DCP) are provided in Table 5.1. The DCP planning controls are yet to be finalised and would be refined as Master Plan is refined.

Table 5.1 Recommended air quality and acoustic amenity planning controls

Air quality and acoustic amenity		
Objectives	Amenity	– Preserve air quality, minimise pollution and improve environmental amenity – Ensure that development fronting a busy road or rail corridor provides an acceptable level of air quality and acoustic amenity for the users and occupants
Controls	Sensitive development near busy roads and rail corridors	A Noise Impact Assessment Report is to accompany development applications for any new mixed use, residential, or a use which the consent authority considers likely to be noise-sensitive, that is adjacent to a busy road or rail corridor. The lots requiring assessment and recommended for assessment are shown in the 'Affected Lots' map (Figure 5.1). The assessment should consider the provisions of the following (or as updated or superseded), as relevant to the proposed land use: – State Environmental Planning Policy (Transport and Infrastructure) 2021 – Development Near Rail Corridors and Busy Roads Interim Guideline – NSW Apartment Design Guide for Residential Flat Buildings – NSW Low Rise Housing Diversity Design Guide for Development Applications
		An air quality assessment is to accompany development applications for any new residential, mixed use, or other use which the consent authority considers likely to be air quality-sensitive, that is adjacent to a busy road or rail corridor. The lots requiring assessment and recommended for assessment are shown in the 'Affected Lots' map (Figure 5.1). The assessment should outline how design considerations outlined in the Development Near Rail Corridors and Busy Roads Interim Guideline have been considered and incorporated to mitigate the potential for adverse air quality impacts. This should give special consideration to ground and first floor of buildings directly facing busy roads.
		Development applications for residential development adjacent to busy roads and rail corridors should demonstrate that the design of the development takes appropriate consideration of the following design principles: – the careful siting and orientation of buildings to ensure appropriate separation distances between sensitive uses and the sources of pollution – minimising the formation of urban canyons which can lead to poor dispersion of air emissions away from sensitive receivers and increase the probability of air quality impacts – taking into account microclimates to help support the sustainable design of buildings that capitalises on natural ventilation and minimise the risk of canyoning – Reorienting and reducing the number of habitable spaces (particularly bedrooms) facing busy roads and rail corridors – Increased glazing specifications and/or reducing the glazed areas for noise-affected facades – Use of landscaping and vegetative screens to act as buffer between pollution sources and sensitive land uses – For development along Great Western Highway, building design should consider the exemplar approaches set out in Section F-2 of the Parramatta Road Corridor Urban Transformation Strategy Planning and Design Guidelines (2016)
	Mixed-use development	Other appropriate measures to improve air quality and acoustic amenity are to be incorporated into the design of mixed-use developments, where required. These may include (but are not limited to): – Where possible, non-residential land uses should be located at lower levels vertically separating the residential components of the development from the noise or pollution source at ground level. – Where possible, the setback distance for the upper level residential component should be maximised to increase the acoustic shielding effects of the lower level building and to increase the dispersion of air pollutants.

Air quality and acoustic amenity

Residential apartments	The design of residential apartments is to carefully consider the internal layout and configuration of residential dwellings to ensure that the natural ventilation requirements detailed in Section 4B of the Apartment Design Guide can be achieved. When designing ventilation to habitable rooms, the following should be demonstrated: – Internal habitable rooms other than bedrooms (e.g., living room, kitchen, study etc.) are to be designed to achieve noise levels of no greater than 50 dBA with windows open during any time of the day. – Bedrooms of residential dwellings are to be designed to achieve noise levels of no greater than 45 dBA with windows open during the night period. *Note: Where noise criteria cannot be achieved concurrently with natural ventilation via open windows, alternative ventilation shall be provided complying with the Building Code of Australia ventilation requirements as a minimum. Noise from background ventilation systems shall be at least 5 dB below the relevant internal noise criteria. Notwithstanding the provision of alternative ventilation, measures to reduce noise to external areas and via open windows shall be incorporated in the overall design and layout of noise sensitive development.*
Facades fronting pollution sources	For residential flat buildings and mixed use developments along busy roads and rail corridors, the following design principles should be considered: – siting mechanical ventilation air inlet ports and natural ventilation windows/doors to maximise the distance from sources of air and noise pollution. – Wintergardens should be encouraged for facades of residential apartments facing Great Western Highway. Ventilation paths on facing the road should be acoustically attenuated and contain adequate air filtration to habitable rooms. See figure below.  – Balconies with a solid balustrade and acoustically lined soffit should be encouraged for facades of residential apartments facing the Alexandra Avenue, Hawkesbury Road and Bridge Road. See figure below. 

Air quality and acoustic amenity

	Noise-generating development	Development applications for noise-generating development (e.g., building plant, child care centres, late night trading premises, licensed venues etc.) adjacent to noise sensitive land uses (e.g., residential premises) as determined by Council should include a noise impact assessment. The assessment should consider the provisions of the following (or as updated or superseded), as relevant to the proposed land use: – NSW EPA Noise Policy for Industry – AAAC Guideline for Child Care Centre Acoustic Assessment – AAAC Guideline for Gymnasium and Exercise Facility Assessment – AAAC Licensed Premises Guideline

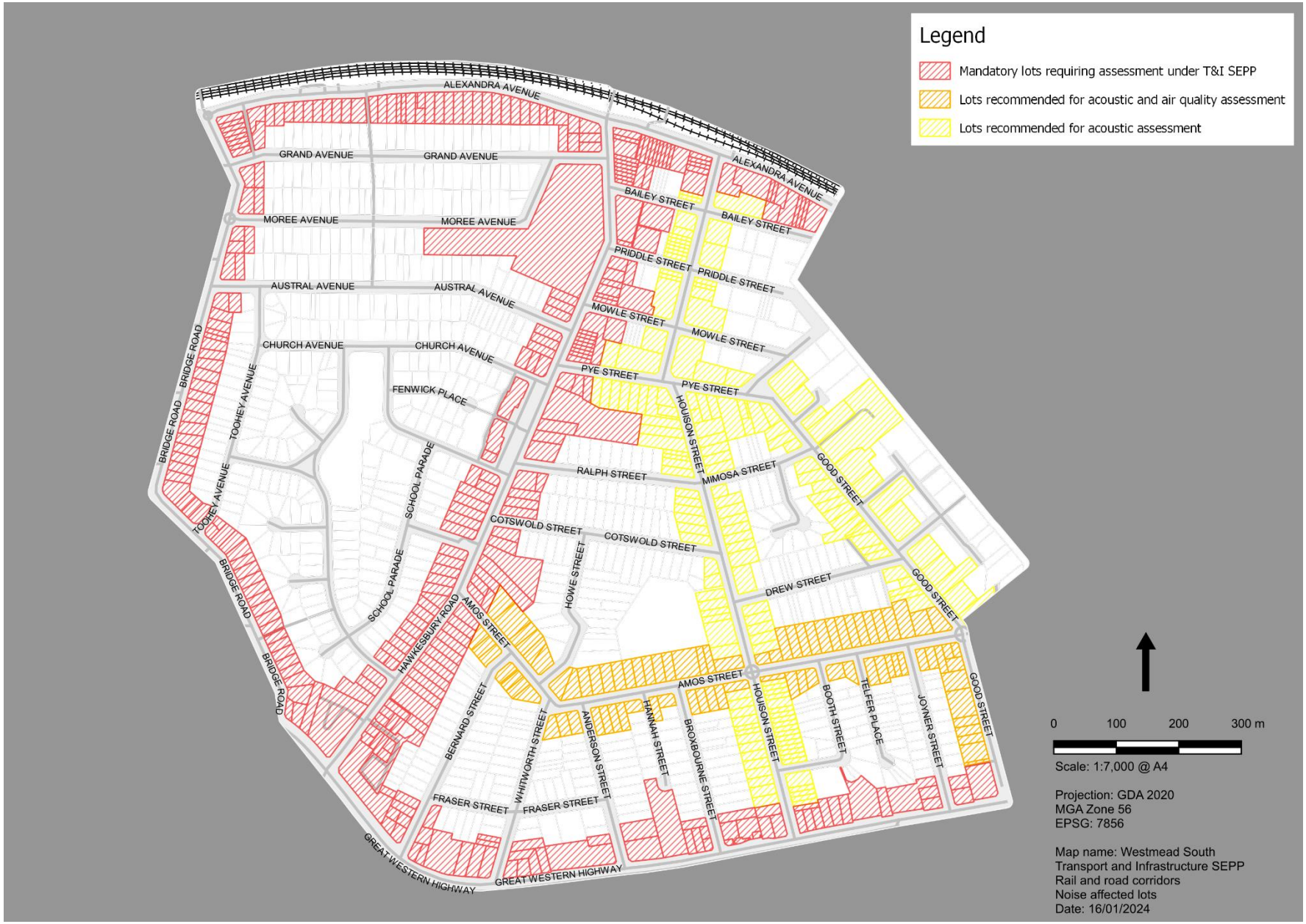


Figure 5.1 Affected lots (air quality and acoustic amenity)

6. Conclusion

Purpose of the report

GHD has been engaged to assess the potential for acoustic and air quality amenity impacts on sensitive receivers for the following scenarios:

– **base-case**: existing built form and traffic volumes (previous 'Stage 1' report)
– **future development scenarios**: potential future built form resulting from the new planning framework for Westmead South and the forecast traffic volumes (this 'Stage 2' report)

The key focus of this study (Stage 2) was to provide an analysis of the future environment of the Westmead South precinct pertaining to air pollution, noise and vibration, and provide an impact assessment on the 'future-case' scenario with respect to current legislation, policies and guidelines.

Outcomes of the noise and vibration impact assessment

An updated transportation noise model was prepared in order to predict future noise levels based on the Draft Westmead South Master Plan. The noise model was based off the calibrated transportation noise model previously prepared as part of the base-case existing Westmead South precinct, and was prepared in SoundPLAN 8.2.

Noise sensitive receivers were grouped into the following three assessment categories based on land use and typical typology:

– Mixed use
– Residential flat buildings
– Low density residential

Mixed use development (up to 25 storeys)

Mixed-use development is proposed in the Westmead South character areas 'Hawkesbury Road High Street' and 'Great Western Highway'. The results indicate that future mixed-use development within the 'Hawkesbury Road High Street' (A0 to A4 and F0, F1) and 'Great Western Highway' (G0 to G3) would require an acoustic assessment and the building adequately designed to achieve the T&I SEPP internal noise levels.

Residential flat building development (up to 25 storeys)

Development areas including residential flat buildings are proposed in the Westmead South character areas 'Northern Living', 'Central Living' and 'Eastern Living'. The results indicate that future RFB development within the 'Northern Living' character area (B2, B3, B4, C, D2, E1, E2 and E4) and 'Central Living' (E5, E7 and E8) would require an acoustic assessment and the building adequately designed to achieve the T&I SEPP internal noise levels. Residential development adjacent to Bridge Road and Hawkesbury Road within the 'Northern Living' and 'Central Living' character areas (D and E) would also require an acoustic assessment, however for the majority of the development areas, standard construction would suffice.

Low to medium density residential (up to two storeys)

The Westmead South character areas 'Westmead Village' and 'Domain Creek Village' would comprise of low to medium density residential development. The results indicate that future low and medium density residential development within the 'Westmead Village' (I, J0, J1 and K) and 'Domain Creek' (J2 and J3) character areas and fronting either Bridge Road or Hawkesbury Road would require an acoustic assessment and the building adequately designed to achieve the T&I SEPP internal noise levels. There is also potential for residential properties within the 'Eastern Living' character area (I) that front either Amos Street, Housion Street or Good Street to require acoustic treatment to achieve the T&I SEPP internal noise levels. However for the majority of the low to medium density residential development areas, standard construction would suffice.

Outcomes of the air quality assessment

Dispersion modelling was used to quantify the future level of key air pollutants from road traffic. An assessment method was developed to determine the risk that incremental concentrations of $PM_{2.5}$ and NO_2 from road traffic and rail would lead to human health impacts at the receivers within the Westmead South Precinct study area.

Sensitive receivers were grouped into the following three assessment categories based on land use and typical typology:

– Mixed use
– Residential flat buildings
– Low density residential

Mixed use development (up to 25 storeys)

Mixed-use development is proposed in the Westmead South character areas ‘Hawkesbury Road High Street’ and ‘Great Western Highway’. The results indicate that future mixed-use development within the ‘Hawkesbury Road High Street' (A0 to A4 and F0, F1) and ‘Great Western Highway’ (G0 to G3) would require special design considerations to ensure air quality objectives are complied with.

Residential flat building development (up to 25 storeys)

Development areas including residential flat buildings are proposed in the Westmead South character areas ‘Northern Living’, ‘Central Living’ and ‘Eastern Living’. The results indicate that future RFB development within the ‘Northern Living’ character area (B1, B2, B3 and C) would require special design considerations to ensure air quality objectives are complied with, below the third storey. Residential development adjacent to Bridge Road within the ‘Northern Living’ and ‘Central Village’ character areas (D1 to D3 and E1 to E8) would also require design consideration.

Low to medium density residential (up to two storeys)

The Westmead South character areas ‘Westmead Village’ and ‘Domain Creek’ would comprise of low to medium density residential development. The results indicate that future low and medium density residential development within the ‘Westmead Village’ character areas (I, J0, J1 and K) and fronting either Bridge Road or Hawkesbury Road would require special design considerations to ensure air quality objectives are complied with. There is also potential for residential properties within the ‘Domain Creek’ character area (J2 and J3) that front either Amos Street or Good Street to design consideration. However for the majority of the low to medium density residential development areas, no special design considerations would be required.

Recommended planning controls

Draft development controls relevant to air quality and acoustic amenity have been provided in Section 5 for inclusion in the Westmead South DCP. In summary, the controls include:

– The lots within Westmead South that require assessment during the DA stage
– Design principles to be considered to improve air quality and acoustic amenity for affected lots
– Considerations to vertically and horizontally separate sources of pollution and the residential component of mixed-use development
– Design considerations to balance natural ventilation requirements and acoustic amenity
– Design considerations to maximise the distance between air intake openings and road sources
– The relevant guidance documents for the assessment of noise-generating development

Appendices

Appendix A

Revised Master Plan (08/04/24)

Revised Master plan (08/04/24)

Legend - Development areas

Area	FSR (of which retail)	Storeys	Land use / description
A0	5.9:1 (0.7:1)	25	Mixed use - Adjacent Station Development site (+ affordable housing)
A1	0.5:1 (Metro station)	1-2	Metro site - station entrance and supporting services
A2	4.5:1 (0.6:1)	20	Mixed use (+ community facility and affordable housing)
A3	4.2:1 (0.6:1)	20	Mixed use (+ affordable housing)
A4	2.8:1 (0.6:1)	15	Mixed use
B1	3.6:1	25	High density residential (+ new open space and through site link)
B2	3.6:1	15	Residential apartments (+ affordable housing and through-site link)
B3	3.6:1	20	Residential apartments (+ commuter car park)
B4	3.2:1	15	Residential apartments (+ affordable housing)
C	2.9:1	12	Residential apartments
D1	2.5:1	8	Residential apartments (+ through site link)
D2	2.5:1	8	Residential apartments
D3	2.5:1	8	Residential apartments
E0	1.2:1	4	Residential apartments
E1	1.6:1	6	Residential apartments
E2	1.6:1	6	Residential apartments
E3	1.6:1	6	Residential apartments
E4	1.6:1	6	Residential apartments
E5	1.6:1	6	Residential apartments
E6	1.6:1	6	Residential apartments
E7	1.6:1	6	Residential apartments
E8	1.6:1	6	Residential apartments
F0	3.2:1 (0.6:1)	8	Mixed use (Hawkesbury Road high street)
F1	3.2:1 (0.6:1)	8	Mixed use (Hawkesbury Road high street)
F2	3.2:1 (0.6:1)	8	Mixed use (Hawkesbury Road high street)
G0	2.5:1 (0.6:1)	8	Mixed use (Great Western Highway E3 zone)
G1-1	2.2:1 (0.6:1)	8	Mixed use (Great Western Highway E3 zone)
G1-2	2.2:1 (0.6:1)	8	Mixed use (Great Western Highway E3 zone)
G1-3	2.2:1 (0.6:1)	8	Mixed use (Great Western Highway E3 zone)
G1-4	2.2:1 (0.6:1)	8	Mixed use (Great western highway extension)
G2-1	1.8:1 (0.6:1)	6	Mixed use (Great western highway extension)
G2-2	1.8:1 (0.6:1)	6	Mixed use (Great western highway extension)
G3	3:1 (0.4:1)	12	Hawkesbury Place site (+ open space and community facility)
H	1.2:1 [no change]	4	Residential apartments (existing blocks)
I	0.7:1	2	Medium density residential (1-2 storeys)
J0	0.7:1	2	Low to medium density residential (1-2 storeys)
J1	0.7:1	2	Low to medium density residential (1-2 storeys)
J2	0.7:1	2	Low to medium density residential (1-2 storeys)
J3	0.7:1	2	Low to medium density residential (1-2 storeys)
K	-	1	Potential Special Character Area or Heritage Conservation Area

Legend - other items

- Westmead South boundary
- SP1 zone - school
- Potential Heritage Conservation Area
- Potential Special Character Area or Heritage Conservation Area
- Potential heritage item
- Existing Heritage Conservation Area
- Unlikely to change (existing heritage item)
- Unlikely to change (school, church, strata title)
- Hawkesbury Road - movement spine
- Key pedestrian streets
- Existing open spaces
- New public plaza - Oakes Centre and Metro plaza
- Potential new open space (dedication or other)
- Existing pocket parks to be zoned RE1
- Hawkesbury Road high street - active frontages
- Great Western Highway frontage - ground floor non-residential uses
- Laneway (dedication or other)
- Proposed laneway (dedication or other)
- Widened link - Dedication through development - 4.5m of 6m setback

Appendix B

Literature review and other relevant policies and guidelines

B-1 Overview of key legislation, policies and guidelines

B-1-1 Relevant legislation and objectives

Table B.1 Key legislation relevant to acoustics and air quality

Legislation	Key objectives	Aim of the legislation
Protection of the Environment Operations Act 1997 and Protection of the Environment Operations (Noise Control) Regulation 2017 Protection of the Environment Operations (Clean Air) Regulation 2021	– Manage noise pollution and offensive noise in NSW – Manage air pollution in NSW	The POEO Act 1997 provides the statutory framework for managing pollution in NSW, including the procedures for issuing licences for environmental protection on aspects such as air and noise pollution control. The POEO (Noise Control) Regulation 2017 (Noise Control Regulation) provide the main legal framework and basis for managing noise in NSW. It also makes certain agencies the appropriate regulatory authority (ARA) responsible for various premises/activities (e.g. local councils, the EPA, or Transport for NSW). The POEO Act also defines 'noise' and 'offensive noise'. The POEO Act has a subjective test for offensive noise, and defines it as any noise that because of its nature, level, character, quality, or time: – could be considered as harmful or likely to be harmful to a person outside the premises or – interferes unreasonably with or is likely to interfere unreasonably with the comfort or repose of a person who is outside the premises. The POEO Regulation controls noise from motor vehicles and marine vessels and sets community standards on acceptable noise intrusion in homes from such appliances as intruder alarms, music amplifiers, air conditioners and powered garden tools. The POEO Act requires that no occupier of any premises causes air pollution (including odour) through a failure to maintain or operate equipment or deal with materials in a proper and efficient manner. For point source emissions where no standard of concentration and/or rate has been set, and for non-point source emissions, the operator must also take all practicable means to minimise and prevent air pollution (sections 124, 125, 126 and 128 of the POEO Act). The POEO Act includes the concept of 'offensive odour' (section 129) and states it is an offence for scheduled activities to emit 'offensive odour', subject to limited defences. The Protection of the Environment Operations (Clean Air) Regulation 2021provides regulatory measures to control emissions from motor vehicles, fuels, and industry.
National Environment Protection Council (NEPC) National Environment Protection (Ambient Air Quality) Measure 2021	Manage air pollution in NSW	The National Environment Protection Council (NEPC) National Environment Protection (Ambient Air Quality) Measure 2021 set uniform national standards for ambient air quality. The document containing these standards is known as the Air NEPM, which also contains goals for air quality pollutants inclusive of particulates and concentration limits, averaging periods and number of allowed exceedances for various pollutant.
Liquor Act 2007 and Liquor Regulation 2018	Manage noise from licensed venues in NSW, including standard conditions of consent	Section 79 of the Liquor Act 2007 provides an informal mechanism for complaints to be made (by residents, Police, local consent authorities and others) where the amenity of local neighbourhoods is unduly disturbed by the conduct of licensed premises and registered clubs (or their patrons). Liquor and Gaming NSW may impose temporary or permanent noise conditions on the licence, where it is deemed appropriate. The Liquor Regulation prescribes matters necessary for the effective operation of the *Liquor Act 2007*
Local Government Act 1993	Provides governance to local councils in NSW	This Act principally deals with the governance of councils in New South Wales. It provides the legal framework for the system of local government in NSW.
Strata Schemes Management Act 2015	Empowers owners corporations to enforce by-laws within strata schemes	The Strata Schemes Management Act recognises the importance of maintaining a peaceful and quiet living environment for strata residents. It sets out guidelines and regulations to address noise-related issues that may arise within strata schemes. The act empowers owners corporations, which are the governing bodies of strata schemes, to enforce rules and by-laws related to noise control

B-1-2 Key guidelines

Table B.2 Air Quality specific guidelines

Policy / Guideline	Scope	Aim of the guideline
NSW EPA Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (2022) (the Approved Methods)	Provides guidance for the modelling and assessment of air pollutants	To list the statutory methods for modelling and assessing emissions of air pollutants from stationary sources in NSW.

Table B.3 Noise and vibration specific guidelines

Policy / Guideline	Scope	Aim of the guideline
Noise Policy for Industry (EPA 2017)	Provides guidance and trigger levels for the assessment of: – Industrial noise – Commercial noise – Mechanical noise	Assessment of industrial, commercial and mechanical noise emission to sensitive receivers under the POEO Act and EP& Act, including noise trigger levels for sensitive land uses
Interim Construction Noise Guideline (DECCW 2009)	Provides guidance for the assessment and management of construction noise	To provide guidance for construction works regulated by the EPA under the POEO Act or local council as the ARA from non-scheduled activities including recommended noise management levels for sensitive land uses and recommended work practices to mitigation impacts
Noise Guide for Local Government (EPA, 2023)	Provides guidance for local councils for noise related issues, including: – Residential noise – Music/entertainment noise – Noisy motor vehicles – Industrial and commercial noise – Construction noise – Transport noise	This noise guide provides practical advice for Council officers on planning, assessment, managing and preventing local noise problems including: – Legal framework for noise control – The assessment of 'offensive noise' – Noise management principles – Regulating noise impacts
NSW Road Noise Policy (DECCW 2011)	Provides guidance for the assessment and management of road traffic noise, including assessment trigger levels.	Identifies strategies that addresses road noise impacts from existing roads, new words, road redevelopment projects and new traffic-generating developments including criteria to assess these impacts.
NSW Rail Infrastructure Noise Guideline (EPA 2013)	Provides guidance for the assessment and management of heavy and light rail noise and vibration, including assessment trigger levels.	A guideline that applies to proposed rail infrastructure projects that would be assessed and determined under the EP&A Act or that are likely to be licensed under the POEO Act. The guidelines specifies noise and vibration trigger levels for, residential land affected by heavy and light rail developments and sensitive land uses near heavy and light rail developments
Assessing Vibration: A technical guideline (DEC 2006)	Provides guidance and trigger levels for the assessment of vibration related impacts such as: – Continuous vibration (e.g. tunnel boring) – Impulsive vibration (e.g. blasting) – Intermittent vibration (e.g. railway and road traffic, construction activities, weight drops in gyms etc)	This guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. Criteria is recommended for continuous vibration, impulsive vibration and intermittent vibration.
AS2107:2016 Acoustics Recommended design	Provides design criteria for internal spaces to control:	This Standard recommends design criteria for conditions affecting the acoustic environment within occupied

Policy / Guideline	Scope	Aim of the guideline
sound levels and reverberation times for building interiors	– Building services noise – External noise intrusion (nearby transport noise) – Reverberation times	space, specifically in background noise and reverberation times.
Building Code of Australia	Provides acoustic privacy criteria and deemed-to-satisfy constructions to control noise transfer between sole occupancy units and building services	The Building Code of Australia (BCA) regulates minimum acceptable construction standards for buildings and sets minimum standards for privacy for Class 2, Class 3 and Class 9a buildings. Part F of the BCA sets minimum requirements for party walls and floors between apartments and for ducts or bulkheads enclosing hydraulic waste pipes. However, it does not deal with other issues such as noise intrusion from outside or noise generated by building services

The Association of Australasian Acoustical Consultants (AAAC) has developed several guidelines with input from AAAC members, to provide guidance for developers, operators, practitioners and local councils. The guidelines are not statutory documents and the guidance within them may be modified to meet specific requirements:

– AAAC Guideline for Child Care Centre Acoustic Assessment
– AAAC Guideline for Apartment and Townhouse Acoustic Rating
– AAAC Guideline for Selection of an Acoustical Consultant
– AAAC Guideline for Commercial Building Acoustics
– AAAC Guideline for Educational Facilities Acoustics
– AAAC Guideline for Health Care Building Acoustics
– AAAC Guideline for Gymnasium and Exercise Facility Assessment

B-1-3 Key planning legislation and instruments

The Environmental Planning and Assessment Act 1979 (EP&A Act) and associated Regulation establishes the planning and environmental assessment system for NSW, including the step and procedures for preparing LEPs and establishes the legislative framework for the bulk of the planning system.

The EP&A Act is followed closely by State Environmental Planning Policies (SEPP), which establish planning controls for specific areas or types of development. The State Government prepares the EP&A Act and SEPPs and Councils prepare Local Environmental Plans (LEP) and Development Control Plans (DCP) to regulate development and land use within a particular local government area.

The relevant legislation and planning instruments that apply to the Westmead South Precinct are presented in the table below along with the key objectives pertaining to acoustics and air quality.

Table B.4 Key legislation and planning policies

Key legislation	Objectives relevant to acoustics and air quality	Relevant requirements
Environmental Planning and Assessment (EP&A) Act 1979 and Environmental Planning and Assessment Regulation 2000	The Act establishes the framework for the assessment and determination of development applications. LEPs provides the legal basis for evaluating proposed developments against the land use and development controls outlined in the LEPs and ensure consistency with state-level policies and guidelines.	Under the EP&A Act 1979, local councils and planning authorities may consider noise impacts when assessing development applications. They may require noise impact assessments, impose conditions on development consents related to noise management, and set noise control standards or guidelines in planning instruments. The EP&A Regulation 2000 provides a regulatory framework for the specific content and requirements of planning instruments including LEPs and DCPs.
State Environmental Planning Policy (Transport and Infrastructure) 2021	A planning policy in NSW that provides requirements for land use development adjacent to busy roads and rail corridors, such as:	The State Environmental Planning Policy (Transport and Infrastructure) 2021 provides a consistent planning regime for infrastructure and the provision of services across NSW.

Key legislation	Objectives relevant to acoustics and air quality	Relevant requirements
	– Residences – Hospitals – Educational institutions – Places of worship – Child care centres Specific guidance is provided in the *Development Near Rail Corridors and Busy Roads - Interim Guideline* (DoP 2008)	If the consent authority considers that land that is in or adjacent to a rail corridor or a busy road is likely to be adversely affected by noise or vibration, the consent authority must not consent to a residential development unless it is satisfied that appropriate measures will be taken to ensure that the internal L_{Aeq} noise levels prescribed in the SEPP can be achieved
Housing SEPP	A planning policy in NSW that provides design guidance for the development of residential apartments. The design principle most relevant to air quality and acoustics is Design Quality Principle 6 Amenity. Specific guidance is provided in the NSW Apartment Design Guide (DoP&E 2015)	Housing SEPP sets out design quality principles and objectives to ensure well-designed residential apartment buildings in NSW. It includes provisions that encourage the incorporation of noise mitigation measures to minimise the impact of noise on apartment occupants and also includes guidance for natural ventilation. The policy recognises the need to address both external noise sources, such as traffic or industrial activities, and internal noise sources within the building, such as sound transmission between apartments.
Cumberland Local Environmental Plan (LEP) 2021	Details the controls for the Local Government Area, including: – Land zoning – Permissible land uses – Building heights – Floor space ratios – Setback and building lines	LEPs are statutory planning documents that guide and control land use and development within the Cumberland LGA. They are prepared by local councils in accordance with the Environmental Planning and Assessment Act 1979 (EP&A Act) and relevant state planning policies.

B-1-4 Design guidance

New sensitive land use development within the Westmead South Precinct would be required to consider the relevant Council planning instruments (Cumberland LEP and DCP). A Development Control Plan would be developed for the Westmead South Masterplan and the planning controls relevant to amenity (noise and air quality) would be informed by the outcomes of this study.

Where development is proposed near rail corridors or busy roads, the supporting Transport and Infrastructure SEPP guideline (*Development Near Rail Corridors and Busy Roads - Interim Guideline*) would need to be considered to ensure potential health and amenity impacts from air and noise pollution are adequately addressed prior to approval.

NSW DPHI have also developed design guidelines that support for the development of Housing SEPP and also low-rise housing through the development application pathway or through the SEPP (Exempt and Complying Development Codes) 2008 pathway.

Each of these documents promote '**Design Principle 6: Amenity**' being:

> *"Good design positively influences internal and external amenity for residents and neighbours. Achieving good amenity contributes to positive living environments and resident well being.*
>
> *Good amenity combines appropriate room dimensions and shapes, access to sunlight, natural ventilation, outlook, visual and acoustic privacy, storage, indoor and outdoor space, efficient layouts and service areas, and ease of access for all age groups and degrees of mobility."*

These planning instruments and design guidelines are summarised below.

Table B.5 Planning and new development guidelines

Planning control / development guideline	Objectives relevant to acoustics and air quality	Relevant guidance
Cumberland Development Control Plan (DCP) 2021	Includes objectives and controls for sensitive land use development relating to: – Acoustic privacy – Air and noise pollution – Natural and cross ventilation	The DCP compliments the LEP by providing more detailed site specific requirements. Part B1, Part B2, Part B3 and Part B4 provide objectives and controls for residential development and other sensitive land uses relating to acoustic privacy, air and noise pollution and ventilation requirements.
Development Near Rail Corridors and Busy Roads - Interim Guideline (DoP 2008)	Provides design guidance supporting the Transport and infrastructure SEPP to reduce health and amenity impacts for land use development near busy roads and rail corridors. For instance: – Great Western Highway – Hawkesbury Road – Alexandra Avenue – Main West rail corridor	This guideline assists in the planning, design and assessment of development in, or adjacent to, rail corridors and busy roads. It supports specific rail and road provisions in the Transport and Infrastructure SEPP by ensuring adjacent development achieves an appropriate acoustic amenity by meeting the internal noise criteria specified. It specifically addresses: – Airborne noise pollution from busy roads – Airborne and groundborne noise pollution from rail corridors – Vibration impacts due to railway operations – Air quality health impacts from air pollution adjacent to busy roads and rail corridors
NSW Apartment Design Guide (DPE, 2015)	Provides design guidance supporting SEPP 65 (Principle 6: Amenity) for residential apartments.	These design guides have been prepared to: – assist developers, planners, urban designers, architects, building designers, landscape architects, builders and other professionals when designing and preparing DAs for low rise diverse housing – assist planning professionals in local government with preparing local controls and in assessing development applications for low rise diverse housing – inform the community of what is required to achieve good design and planning practice for diverse low rise residential dwellings, as a development application. They provide design guidance to support Principle 6 – Amenity for residential development, including: – Acoustic privacy – Air and noise pollution – Natural and cross ventilation
Low rise housing Diversity Design Guide for Development Applications (NSW DPE, 2020)	Provides design guidance for complying developments for dual occupancies, manor houses, terraces and multi dwelling housing	
Low rise housing Diversity Design Guide for Complying Developments (NSW DPE, 2020)	Provides design guidance for complying developments for dual occupancies, manor houses and terraces	

B-2 Design objectives

B-2-1 SEPP (Transport and Infrastructure) 2021

The State Environmental Planning Policy (Transport and Infrastructure) 2021 (T&I SEPP) provides a consistent planning regime for infrastructure and the provision of services across NSW. If the consent authority considers that land that is in or adjacent to a rail corridor or a busy road is likely to be adversely affected by noise, vibration or vehicle emissions, the consent authority must not consent to a residential development unless it is satisfied that appropriate measures will be taken to ensure that the internal L_{Aeq} noise levels prescribed in the SEPP can be achieved and that vehicle emissions can be adequately controlled .

The construction of sensitive developments such as residential dwellings, churches, hospitals, and schools on land in or immediately adjacent to a rail corridor or busy road triggers the requirement to consider air and noise pollution under the Transport and Infrastructure SEPP.

Clause 2.119 notes that proposed developments with frontage to classified roads must not be sensitive to traffic noise or vehicle emissions or must be located and adequately designed to ameliorate potential traffic noise and vehicle emissions from adjacent classified roads.

The definition of a 'rail corridor' and a 'busy road' as defined in the Transport and Infrastructure SEPP are provided below. The key roads requiring assessment under the T&I SEPP are presented in the table below.

Table B.6 Clause 2.100 and Clause 2.120 of the T&I SEPP

Corridor	Clause	Assessment requirement	
		Mandatory	**Non-mandatory**
	**Clause 2.100** Rail corridor: as defined by clause 2.100 of the Infrastructure SEPP. – Land that is owned, leased managed or controlled by a public authority for the purpose of a railway or rail infrastructure facilities, or – Land that is zoned under an environmental planning instrument predominantly or solely for the development for purpose of a railway or rail infrastructure facilities, or – Land in respect of which the Minister has granted approval under Part 3A or (before its repeal) Division 4 of Part 5 of the Act for the carrying out of development (or for a concept plan for a project comprising or including development) for the purpose of a railway or rail infrastructure facilities.	**25 metres from the nearest track line (noise and vibration):** Main West Line (between Parramatta and Wentworthville)	**60 metres from the nearest track line (noise):** Main West Line (between Parramatta and Wentworthville)
	**Clause 2.120** A busy road is defined as: – freeway, a tollway or a transitway or any other road with an annual average daily traffic volume of more than 20,000 vehicles (based on the traffic volume data published on the website of TfNSW)	**Freeway, a tollway or a transitway or any other road with an annual average daily traffic volume of more than 20,000 vehicles:** – Great Western Highway (Map 11D) – Hawkesbury Road (Map 11D) – Bridge Road (Map 11D)	**Road corridors carrying between 10,000 and 20,000 AADT:** Alexandra Avenue (2023 traffic counts)

The *Development Near Rail Corridors and Busy Roads - Interim Guideline* is a document prepared by the Department of Planning to reduce the health impacts of rail and road noise and emissions to air on sensitive adjacent developments. The Transport and Infrastructure SEPP refers to the guidelines that must be considered where development is proposed in, or adjacent to, specific roads and railway corridors under clauses 2.100 (rail) and 2.120 (road). The internal noise levels from the Interim Guideline to be achieved are provided below.

Table B.7 Transport and Infrastructure SEPP internal noise levels

Development type	Room type	Internal noise level	Time period
Residential	Bedrooms	35 dBA (45 dBA with open windows)[1]	Night
	Other habitable rooms	40 dBA (50 dBA with open windows)[1]	Day / 24 hours
Hospitals	Wards	35 dBA	When in use

Development type	Room type	Internal noise level	Time period
	Other noise sensitive areas	45 dBA	When in use
Place of worship	Internal areas (learning spaces)	40 dBA	When in use
Educational institutes and child care centres	Internal areas (learning spaces)	40 dBA	When in use
Notes: 1) If internal noise levels with windows or doors open exceed the criteria by more than 10dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also to meet the ventilation requirements of the Building Code of Australia.			

The Interim Guideline provides the following instances when air quality should be a design consideration:

– Within 10 metres of a congested collector road (traffic speeds of less than 40 km/hr at peak hour) or a road grade > 4% or heavy vehicle percentage flows > 5%,

– Within 20 metres of a freeway or main road (with more than 2500 vehicles per hour, moderate congestions levels of less than 5% idle time and average speeds of greater than 40 km/hr),

– Within 60 metres of an area significantly impacted by existing sources of air pollution (road tunnel portals, major intersection / roundabouts, overpasses or adjacent major industrial sources), or

– As considered necessary by the approval authority based on consideration of site constraints, and associated air quality issues.

While the points above provide situations in which air quality should be considered, no quantitative objectives are provided in the guideline to assess to and as such numerical objectives have been sourced from The *National Environment Protection (Ambient Air Quality) Measure (*National Environment Protection Council (NEPC), 2021*).*

B-2-2 Air quality objectives

The *National Environment Protection (Ambient Air Quality) Measure* (Air NEPM) and the *National Environment Protection (Air Toxics) Measure* (Toxics NEPM) were developed to provide benchmark standards for ambient air quality to allow for the adequate protection of human health and well-being (National Environment Protection Council, 2021). These measures provide criteria for a range of pollutants and VOCs that would be expected from vehicle emissions. The table below provides a summary of the air quality objectives for key pollutants of concern, nitrogen dioxide (NO_2) and particulate matter ($PM_{2.5}$), as discussed in section 0. Objectives for $PM_{2.5}$ are expected to change from 1 January 2025 as outlined in the Air NEPM and are shown in brackets beside the current objective.

Table B.8 Air quality assessment objectives

Pollutant	Averaging period	Statistic	Maximum concentration	
			µg/m^3	ppm
$PM_{2.5}$	1 day	Maximum	25 (20)	-
	1 year	Average	8 (7)	-
NO_2	1 hour	Maximum	164	0.08
	1 year	Average	31	0.015

B-2-3 Housing SEPP (Design Principle: Amenity)

Amendments to the Housing SEPP 2021 came into effect in December 2023 and repeals SEPP 65 – Design Quality of Residential Apartment Development. The amended Housing SEPP incorporates provisions regarding the design of residential development, and application of the Apartment Design Guide into the Housing SEPP.

Residential flat buildings

The NSW Apartment Design Guide (Department of Planning and Environment, 2005) details how residential apartment development proposals can meet these principles (including acoustic amenity) through good design and planning practice. This Apartment Design Guide is a resource to improve the planning and design of residential apartment development in NSW. The Apartment Design Guide is to be used in conjunction with Housing SEPP which sets out the NSW Government's policy direction for residential apartment development in NSW.

The relevant objectives of the Apartment Design Guide are reproduced in the table below. For each objective the ADG, provides design guidance and design criteria (where relevant).

Table B.9 Apartment Design Guide objectives (natural ventilation and noise and pollution)

Type	Objective no.	Objectives
Natural ventilation	4B-1	All habitable rooms are naturally ventilated
	4B-2	The layout and design of single aspect apartments maximises natural ventilation
	4B-3	The number of apartments with natural cross ventilation is maximised to create a comfortable indoor environment for residents
Acoustic privacy	4H-1	Noise transfer is minimised through the siting of buildings and building layout
	4H-2	Noise impacts are mitigated within apartments through layout and acoustic treatments
Noise and pollution	4J-1	In noisy or hostile environments the impacts of external noise and pollution are minimised through the careful siting and layout of buildings
	4J-2	Appropriate noise shielding or attenuation techniques for the building design, construction and choice of materials are used to mitigate noise transmission

SEPP 65 development in locations adjacent to rail corridors and busy roads must have regard to the *Development Near Rail Corridors and Busy Roads - Interim Guideline*

Low rise housing

The Low Rise housing Diversity Design Guide for Development Applications (NSW DPIE, 2020) and Low rise housing Diversity Design Guide for Complying Development (NSW DPIE, 2020) applies to development that contains two or more dwellings and is no more than two storeys in height, including:

– Dual occupancies (Section 2.1 of the Design Guide)
– Main houses and 'one above the other' dual occupancies (Section 2.2 of the Design Guide)
– Multi-dwelling houses (terraces) (Section 2.3 of the Design Guide)
– Multi-dwelling houses (town houses and villas) (Section 2.4 of the Design Guide)

Table B.10 Low rise housing diversity design objectives (natural ventilation and noise and pollution)

Rype	Objective no.	Design Criteria
Acoustic privacy	2.1P-1	Electrical, mechanical, hydraulic and air conditioning equipment is housed so that it does not create an 'offensive noise' as defined in the *Protection of the Environment Operations Act 1997* either within or at the boundaries of any property at any time of the day.
Natural ventilation	2.1I	All habitable rooms are naturally ventilated
		Each dwelling is naturally cross ventilated

Rype	Objective no.	Design Criteria
Noise and pollution	2.1Q-1	Any development within the 20 ANEF contour is to be constructed to comply with AS 2021:2015 Acoustics – Aircraft Noise Intrusion.
		Dwellings that are within 100m of a classified road or 80m from a rail corridor are to have LAeq measures not exceeding: – In any bedroom: 35dB(A) between 10pm-7am. – Anywhere else in the building (other than a kitchen, garage, bathroom or hallway): 40dB(A) at any time. This is achieved by: – Providing a full noise assessment prepared by a qualified acoustic engineer; and – Complying with relevant noise control treatment for sleeping areas and other habitable rooms in Appendix C of RMS *Development Near Rail Corridors and Busy Roads - Interim Guideline.*

Note: Development that is on land immediately adjacent to a rail corridor and development that involves penetration of the ground to a depth of 2m within 25m of a rail corridor may be integrated development and *State Environmental Planning Policy (Infrastructure) 2007* applies.

Appendix C

Future transport noise model traffic volumes

Table C.1 Road traffic volumes (source: SCT Consulting)

Road	Direction	2023						2041					
		Day			Night			Day			Night		
		LV	HV	total	LV	HV	total	LV	HV	total	LV	HV	total
M4 Motorway	WB	26410	3044	29454	3951	461	4411	26410	3044	29454	3951	461	4411
M4 Motorway	EB	23363	2317	25680	3741	563	4304	23363	2317	25680	3741	563	4304
Great Western Highway	WB	14239	925	15164	2130	140	2270	18545	1024	19569	2774	155	2929
Great Western Highway	EB	12596	704	13300	2017	171	2188	16409	784	17193	2628	191	2818
Bridge Road	SB	3605	313	3918	463	31	494	7181	368	7549	922	36	959
Bridge Road	NB	4358	347	4705	696	47	743	7432	415	7847	1187	56	1243
Hawkesbury Road	NB	5830	357	6187	868	72	940	3688	306	3994	549	62	611
Hawkesbury Road	SB	5823	404	6227	658	36	694	3478	346	3824	393	31	424
Houison Street	NB	534	30	564	38	2	40	1016	41	1057	72	3	75
Houison Street	SB	1232	61	1293	72	3	75	1762	76	1839	103	4	107
Amos Street	WB	1181	59	1240	126	4	130	4695	131	4826	501	9	510
Amos Street	EB	991	41	1032	90	3	93	4624	110	4734	420	8	428
Austral Avenue	WB	707	13	720	60	4	64	707	13	720	60	4	64
Austral Avenue	EB	840	22	862	78	2	80	840	22	862	78	2	80
Grand Avenue	WB	585	11	596	41	0	41	1294	28	1321	91	0	91
Grand Avenue	EB	322	8	330	29	0	29	856	20	876	77	0	77
Alexandra Avenue	WB	2607	149	2756	247	25	272	5576	211	5788	528	35	564
Alexandra Avenue	EB	3144	210	3354	291	34	325	5375	256	5631	497	41	539
Alexandra Avenue (east)	WB	4171	238	4410	395	40	435	7336	307	7642	695	51	746
Alexandra Avenue (east)	EB	5030	336	5366	466	54	520	7408	386	7794	686	63	748
Good Street	NB	1444	100	1544	165	13	178	1444	100	1544	165	13	178
Good Street	SB	1370	105	1475	140	13	153	1370	105	1475	140	13	153

Appendix D

Air quality modelling methodology

D-1 Emissions inventory

The road links described in Table E.6 were included in the air quality dispersion model.

Table D.2 Modelled road links

Road	Length (m)	Speed (km/hr)
Western Motorway	700	80
Great Western Hwy	1830	60
Bridge Rd	1110	40
Hawksbury Rd	1180	40
Houison St	1130	40
Amos St	1000	40
Austral Ave	580	20
Grand Ave	730	20
Alexandra Ave	650	20
Park Pde	1260	20
Good St	1100	20
Locomotive rail line	2300	30

Hourly light and heavy vehicle traffic counts used to estimate emissions for each road link are presented in Table E.7 and E.8 respectively for the existing scenario, and Table E.9 and E.10 respectively for the future scenario. Locomotive counts used to estimate emissions along the rail line are presented in Table E.11.

Table D.3 Hourly diurnal light vehicle traffic counts – existing scenario

Road	Western Motorway	Western Motorway	Great Wstn Hwy	Great Wstn Hwy	Bridge Rd	Bridge Rd	Hawksbury Rd	Hawksbury Rd	Houison St	Houison St	Amos St	Amos St	Austral Ave	Austral Ave	Grand Ave	Grand Ave	Alexandra Ave Park Pd	Alexandra Ave Park Pd	Good St	Good St
Hour	WB	EB	WB	EB	SB	NB	NB	SB	NB	SB	WB	EB	WB	EB	WB	EB	WB	EB	NB	SB
0	354	232	191	125	23	41	39	48	2	3	11	6	3	3	2	1	28	12	12	10
1	202	141	109	76	19	21	22	39	2	2	4	4	2	3	2	2	7	7	5	7
2	141	109	76	59	16	14	12	18	1	1	4	2	1	2	1	1	4	4	2	1
3	150	121	81	65	16	19	17	28	0	1	3	3	1	3	0	1	6	4	4	4
4	213	206	115	111	30	32	39	35	0	2	8	5	1	3	3	1	14	17	8	8
5	467	640	252	345	83	109	155	97	6	10	19	13	9	9	5	7	27	47	18	13
6	788	1241	425	669	123	240	370	142	13	22	28	25	23	22	9	4	53	112	54	39
7	1052	1671	567	901	223	367	635	266	41	58	63	51	39	50	21	14	100	273	98	76
8	1332	1988	718	1072	245	412	653	355	102	147	121	95	69	95	53	74	146	442	220	170
9	1241	1769	669	954	217	300	520	292	29	82	70	62	42	47	33	15	116	244	84	95
10	1411	1556	761	839	209	228	415	338	23	46	59	59	32	36	22	14	119	178	61	58
11	1614	1556	870	839	202	228	376	376	26	45	69	59	31	35	24	13	137	175	52	59
12	1838	1554	991	838	219	237	364	394	27	60	76	61	33	44	28	16	159	185	57	63
13	1946	1554	1049	838	218	270	410	409	25	47	70	60	42	38	25	17	166	170	72	59
14	2159	1578	1164	851	310	297	408	448	47	71	92	74	41	47	32	41	198	184	118	79
15	2415	1634	1302	881	321	332	362	569	39	158	98	79	63	67	68	22	234	240	105	124
16	2517	1692	1357	912	352	310	330	573	34	124	90	74	72	66	66	22	264	228	113	115
17	2550	1890	1375	1019	309	367	350	560	42	155	102	86	77	91	77	21	282	245	136	137
18	2168	1716	1169	925	298	332	334	441	37	103	97	86	69	80	59	14	270	207	109	117
19	1551	1308	836	705	219	261	287	313	27	59	74	66	45	59	31	14	166	171	87	96
20	1389	1022	749	551	147	229	202	278	20	43	59	45	27	51	26	13	142	121	72	72
21	1228	874	662	471	116	188	184	211	15	34	41	34	25	34	20	12	108	81	60	50
22	1024	638	552	344	91	141	134	155	8	19	30	21	13	22	13	8	67	56	39	35
23	610	414	329	223	62	79	80	96	6	12	19	11	7	11	6	4	41	32	23	23

Table D.4 Hourly diurnal heavy vehicle traffic counts – existing scenario

Road	Western Motorway	Western Motorway	Great Wstn Hwy	Great Wstn Hwy	Bridge Rd	Bridge Rd	Hawksbury Rd	Hawksbury Rd	Houison St	Houison St	Amos St	Amos St	Austral Ave	Austral Ave	Grand Ave	Grand Ave	Alexandra Ave Park Pd	Alexandra Ave Park Pd	Good St	Good St
Hour	WB	EB	WB	EB	SB	NB	NB	SB	NB	SB	WB	EB	WB	EB	WB	EB	WB	EB	NB	SB
0	26	23	8	7	0	1	4	1	0	0	0	0	0	0	0	0	1	1	0	0
1	20	20	6	6	0	2	4	1	0	0	0	0	0	0	0	0	2	1	0	1
2	20	20	6	6	0	0	3	1	0	0	0	0	0	0	0	0	2	1	1	0
3	23	30	7	9	1	0	3	3	0	0	0	0	0	0	0	0	3	1	0	0
4	46	43	14	13	5	3	8	5	0	0	0	1	0	0	0	0	3	3	0	1
5	82	99	25	30	7	9	12	6	0	1	1	0	1	0	0	0	3	6	1	1
6	151	270	46	82	11	23	29	13	2	1	1	1	2	1	0	0	6	16	5	5
7	197	247	60	75	20	32	33	30	3	3	3	2	0	1	1	1	8	23	9	4
8	197	247	60	75	30	34	35	27	5	4	7	4	2	4	1	2	10	35	17	14
9	217	234	66	71	16	30	35	29	5	4	6	8	1	2	0	2	9	17	5	10
10	240	201	73	61	17	23	33	36	1	3	4	4	0	1	1	1	10	16	7	6
11	250	197	76	60	17	20	33	37	1	4	5	2	0	0	0	0	10	15	5	4
12	260	184	79	56	20	18	24	41	1	4	4	2	1	2	1	1	11	11	6	5
13	270	171	82	52	16	28	26	41	1	4	5	3	1	0	0	0	12	11	7	6
14	273	155	83	47	25	23	32	37	2	5	4	2	1	2	1	0	13	16	6	5
15	286	151	87	46	44	35	30	39	3	11	6	3	1	2	1	0	13	16	7	7
16	253	135	77	41	34	28	16	32	2	7	4	3	2	4	2	1	15	13	6	9
17	204	128	62	39	35	25	17	25	2	6	4	4	0	1	1	0	14	11	7	11
18	148	105	45	32	20	20	16	13	2	3	2	2	0	1	0	0	10	13	5	8
19	92	66	28	20	9	16	12	8	1	1	2	1	2	1	0	0	5	6	4	6
20	82	53	25	16	6	8	8	6	1	1	2	1	1	1	1	0	5	4	5	5
21	72	43	22	13	4	7	7	3	0	1	1	0	1	0	1	0	4	3	4	5
22	56	33	17	10	3	5	5	4	0	1	1	0	1	1	0	0	3	2	4	3
23	36	26	11	8	4	4	4	2	0	0	1	1	0	0	0	0	2	3	2	2

Table D.5 Hourly diurnal light vehicle traffic counts – future scenario

Road	Western Motorway	Western Motorway	Great Wstn Hwy	Great Wstn Hwy	Bridge Rd	Bridge Rd	Hawksbury Rd	Hawksbury Rd	Houison St	Houison St	Amos St	Amos St	Austral Ave	Austral Ave	Grand Ave	Grand Ave	Alexandra Ave	Alexandra Ave	Park Pd	Park Pd	Good St	Good St
Hour	WB	EB	WB	EB	SB	NB	NB	SB	NB	SB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	NB	SB
0	354	232	249	163	46	70	25	29	4	4	44	28	3	3	4	3	60	21	79	28	12	10
1	202	141	142	99	38	36	14	23	4	3	16	19	2	3	4	5	15	12	20	16	5	7
2	141	109	99	77	32	24	8	11	2	1	16	9	1	2	2	3	9	7	11	9	2	1
3	150	121	105	85	32	32	11	17	0	1	12	14	1	3	0	3	13	7	17	9	4	4
4	213	206	150	145	60	55	25	21	0	3	32	23	1	3	7	3	30	29	39	40	8	8
5	467	640	328	449	165	186	98	58	11	14	76	61	9	9	11	19	58	80	76	111	18	13
6	788	1241	554	872	245	409	234	85	25	31	111	117	23	22	20	11	113	191	149	264	54	39
7	1052	1671	738	1174	444	626	402	159	78	83	250	238	39	50	46	37	214	467	281	643	98	76
8	1332	1988	936	1290	388	555	472	174	204	249	390	364	69	95	152	173	302	598	467	940	220	170
9	1241	1769	871	1243	432	512	329	174	55	117	278	289	42	47	73	40	248	417	326	575	84	95
10	1411	1556	991	1093	416	389	263	202	44	66	235	275	32	36	49	37	255	304	335	419	61	58
11	1614	1556	1133	1093	402	389	238	225	49	64	274	275	31	35	53	35	293	299	385	412	52	59
12	1838	1554	1291	1092	436	404	230	235	51	86	302	285	33	44	62	43	340	316	447	436	57	63
13	1946	1554	1366	1092	434	460	259	244	48	67	278	280	42	38	55	45	355	291	467	401	72	59
14	2159	1578	1516	1109	617	507	258	268	89	102	366	345	41	47	71	109	424	315	557	434	118	79
15	2415	1634	1696	1148	639	566	229	340	74	226	390	369	63	67	150	58	501	410	658	565	105	124
16	2517	1692	1767	1188	701	529	209	342	65	177	358	345	72	66	146	58	565	390	743	537	113	115
17	2550	1890	1790	1434	716	774	163	373	71	184	497	481	77	91	136	80	614	577	738	679	136	137
18	2168	1716	1523	1205	594	566	211	263	70	147	386	401	69	80	130	37	578	354	760	488	109	117
19	1551	1308	1089	918	436	445	182	187	51	84	294	308	45	59	69	37	355	292	467	403	87	96
20	1389	1022	976	718	293	391	128	166	38	62	235	210	27	51	58	35	304	207	400	285	72	72
21	1228	874	862	614	231	321	116	126	29	49	163	159	25	34	44	32	231	138	304	191	60	50
22	1024	638	719	448	181	240	85	93	15	27	119	98	13	22	29	21	143	96	189	132	39	35
23	610	414	429	291	123	135	51	57	11	17	76	51	7	11	13	11	88	55	115	75	23	23

Table D.6 Hourly diurnal heavy vehicle traffic counts – future scenario

Road	Western Motorway	Western Motorway	Great Wstn Hwy	Great Wstn Hwy	Bridge Rd	Bridge Rd	Hawksbury Rd	Hawksbury Rd	Houison St	Houison St	Amos St	Amos St	Austral Ave	Austral Ave	Grand Ave	Grand Ave	Alexandra Ave	Alexandra Ave	Park Pd	Park Pd	Good St	Good St
Hour	WB	EB	WB	EB	SB	NB	NB	SB	NB	SB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	NB	SB
0	26	23	9	8	0	1	3	1	0	0	0	0	0	0	0	0	1	1	2	2	0	0
1	20	20	7	7	0	2	3	1	0	0	0	0	0	0	0	0	3	1	4	2	0	1
2	20	20	7	7	0	0	3	1	0	0	0	0	0	0	0	0	3	1	4	2	1	0
3	23	30	8	10	1	0	3	3	0	0	0	0	0	0	0	0	4	1	6	2	0	0
4	46	43	15	14	6	4	7	4	0	0	0	3	0	0	0	0	4	4	6	6	0	1
5	82	99	28	33	8	11	10	5	0	1	2	0	1	0	0	0	4	7	6	11	1	1
6	151	270	51	91	13	27	25	11	3	1	2	3	2	1	0	0	9	19	12	29	5	5
7	197	247	66	84	24	38	28	26	4	4	7	5	0	1	3	3	11	28	16	42	9	4
8	197	247	65	80	33	37	32	24	7	6	13	10	2	4	3	4	13	38	21	61	17	14
9	217	234	73	79	19	36	30	25	7	5	13	22	1	2	0	5	13	21	19	31	5	10
10	240	201	81	68	20	27	28	31	1	4	9	11	0	1	3	3	14	19	21	29	7	6
11	250	197	84	67	20	24	28	32	1	5	11	5	0	0	0	0	14	18	21	28	5	4
12	260	184	87	62	24	22	21	35	1	5	9	5	1	2	3	3	16	13	23	20	6	5
13	270	171	91	58	19	33	22	35	1	5	11	8	1	0	0	0	17	13	25	20	7	6
14	273	155	92	52	29	27	27	32	3	6	9	5	1	2	3	0	18	19	27	29	6	5
15	286	151	96	51	52	42	26	33	4	14	13	8	1	2	3	0	18	19	27	29	7	7
16	253	135	85	46	40	33	14	27	3	9	9	8	2	4	5	3	21	16	31	24	6	9
17	204	128	71	48	44	34	13	21	3	7	12	12	0	1	2	1	21	18	28	24	7	11
18	148	105	50	36	24	24	14	11	3	4	4	5	0	1	0	0	14	16	21	24	5	8
19	92	66	31	22	11	19	10	7	1	1	4	3	2	1	0	0	7	7	10	11	4	6
20	82	53	28	18	7	10	7	5	1	1	4	3	1	1	3	0	7	5	10	7	5	5
21	72	43	24	14	5	8	6	3	0	1	2	0	1	0	3	0	6	4	8	6	4	5
22	56	33	19	11	4	6	4	3	0	1	2	0	1	1	0	0	4	2	6	4	4	3
23	36	26	12	9	5	5	3	2	0	0	2	3	0	0	0	0	3	4	4	6	2	2

Table D.7 Hourly diurnal locomotive counts

Hour	Rail line
0	2
1	2
2	2
3	2
4	2
5	2
6	1
7	1
8	1
9	2
10	2
11	2
12	2
13	2
14	1
15	1
16	1
17	2
18	2
19	2
20	2
21	2
22	1
23	2

D-2 GRAMM model settings

GRAMM settings are summarised in Table E.10.

Table D.8 Parameters used in GRAMM for meteorological modelling

Parameter	Value
General	
Number of wind speeds	17
Wind speeds (m/s)	0.25, 0.75, 1.5, 2.5, 3.5, 4.5, 5.5, 6.5, 7.5, 8.5, 9.5, 11, 13, 15, 17, 19, 21
Number of wind direction sectors	36
Number of classified weather situations	2088
Horizontal grid resolution	100 m
Vertical thickness of first layer	10 m

Parameter	Value
Number of vertical layers	15
Vertical stretching factor	1.4
Relative top layer height	3874
Maximum time step	10 s
Modelling time	3600 s
Relaxation velocity	0.15
Relaxation scalars	0.15
GRAMM dmain constraints	
North	6265700 m
East	328100 m
South	6241000 m
West	296400 m

D-3 GRAL model settings

The GRAL model was set up to predict maximum 1-hour average concentrations across the modelling domain based on a Cartesian grid of points with an equal spacing of 4 m in the x and y directions at four elevations (1.5m, 4.5m, 7.5m and 10.5 m), to represent the breathable zone for human sensitive receptors. A GRAMM model was prepared as described above with match to observations performed at Parramatta North AQMS and was used as the meteorological input to the model to simulate all possible weather conditions.

GRAL settings are summarised in Table E.11.

Table D.9 Parameters used in GRAL for dispersion modelling

Parameter	Value
General	
Dispersion time	3600 s
Particles per second	100
Obstacles	Buildings
Concentration grid	
Horizontal grid resolution	4 m
Vertical thickness of first layer	3 m
Number of horizontal slices	4
Internal flow field grid	
Horizontal grid resolution	2 m
Vertical thickness of first layer	2 m
Vertical stretching factor	1.01
Number of cells in z-direction	40
GRAL domain constraints	
North	6257556 m
East	314776 m
South	6255700 m
West	312636 m

ghd.com

The Power of Commitment